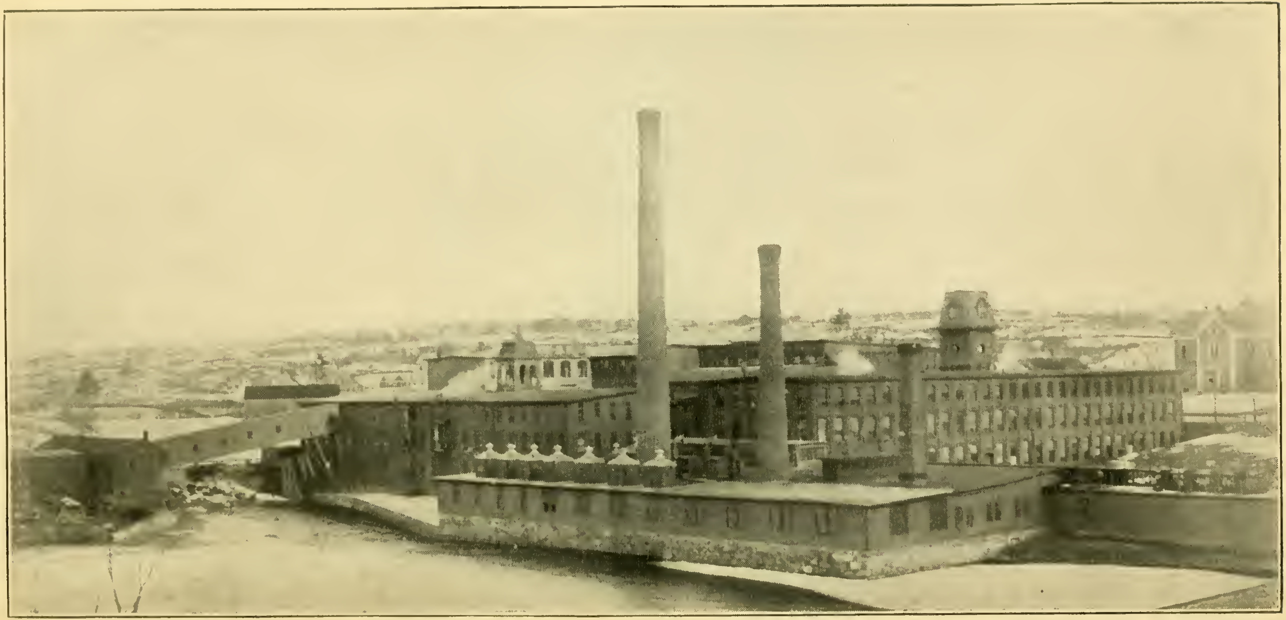
FROM
GEORGE DRAPER & SONS

HOPEDALE, MASS.

LIBRARY

SOUTHEASTERN MASSACHUSETTS UNIVERSITY · UNITATE · 1895 · FORTIOR ·



UPPER HALF OF OUR WORKS. LOWER HALF IN PROCESS OF ALTERATION.

FACTS AND FIGURES

FOR

TEXTILE MANUFACTURERS,

CONCERNING THE

Proper Methods of Equipping and Running Mills,

INCLUDING

SPECIAL TREATISES ON

CARDING, SPINNING, SPOOLING, WARPING, DYEING, REELING, TWISTING AND WEAVING.

ALSO

GENERAL HISTORY, MATHEMATICAL TABLES,

AND A

FULL LIST OF THE PATENTED COTTON MACHINERY
INTRODUCED AND SOLD BY
THE FIRM OF

GEO. DRAPER & SONS,

AND THE FOLLOWING COMPANIES FOR
WHOM THEY ARE THE SOLE AGENTS:

THE SAWYER SPINDLE CO.,
HOPEDALE MACHINE CO.,
DUTCHER TEMPLE CO.,
NORTHROP LOOM CO.

George Otis Draper

PRESENTED WITH THEIR COMPLIMENTS.

HOPEDALE, MASS., U. S. A.
1896.

Copyright, *1896*,
BY GEO. DRAPER & SONS,

WRITTEN AND COMPILED BY
GEORGE OTIS DRAPER.

DATES OF ISSUE OF GEO. DRAPER & SONS' CATALOGUES.

1st—1871—50 pages.
2d—1872—66 pages.
3d—1873—75 pages.
4th—1876—66 pages.
5th—1881—126 pages.
6th—1887—214 pages.
7th—1893—80 pages. (No advertising, mostly tables.)
8th—1896—272 pages.

Printed by
COOK & SONS, MILFORD, MASS.

TS1591
D76
1892

PREFACE.

The firm of GEO. DRAPER & SONS, HOPEDALE, MASS., occupy a position of peculiar bearing and importance to the manufacturing world. They come from a long line of Textile Manufacturers. Thomas Draper was a well known manufacturer and fuller of cloth in England in 1630, and his son James carried the same trade to America in 1650.

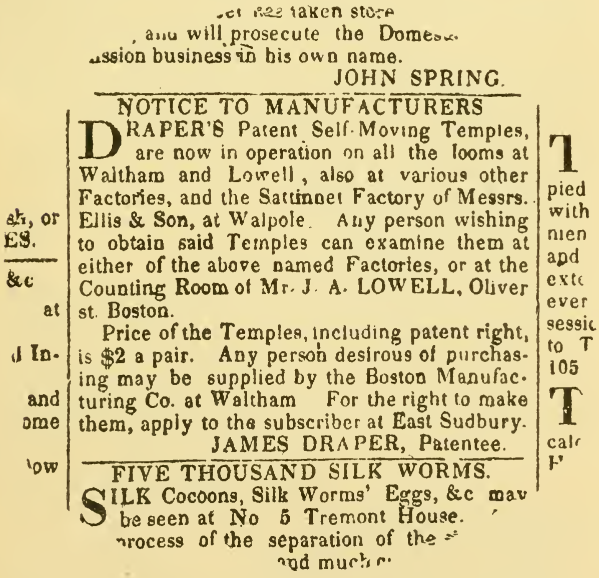
The present business of introducing patented improvements in cotton machinery was started by a direct descendant of the above line, and has been carried on continuously as follows:

1816—IRA DRAPER.

Revolving Temples and Improved Looms.

1825—JAMES DRAPER, son of Ira.

Temple business continued.



...taken store
, and will prosecute the Domes...
...ssion business in his own name.
JOHN SPRING.

NOTICE TO MANUFACTURERS

DRAPER'S Patent Self-Moving Temples, are now in operation on all the looms at Waltham and Lowell, also at various other Factories, and the Sattinnet Factory of Messrs. Ellis & Son, at Walpole. Any person wishing to obtain said Temples can examine them at either of the above named Factories, or at the Counting Room of Mr. J. A. LOWELL, Oliver st. Boston.

Price of the Temples, including patent right, is $2 a pair. Any person desirous of purchasing may be supplied by the Boston Manufacturing Co. at Waltham. For the right to make them, apply to the subscriber at East Sudbury.
JAMES DRAPER, Patentee.

FIVE THOUSAND SILK WORMS.

SILK Cocoons, Silk Worms' Eggs, &c may be seen at No 5 Tremont House.
...process of the separation of the...
...and much...

The above is a reprint from the advertising columns of the first Boston Daily Evening Transcript, Vol 1—No. 1, issued July 24, 1830.

1838—E. D. DRAPER, brother of James.

Temples.

1852—E. D. & G. DRAPER, latter also brother of James. Temples, Let-off Motions and other improvements.

1868—GEO. DRAPER & SON, E. D. Draper bought out by Wm. F. Draper, son of Geo. Draper.
Cotton machinery improvements.

1877—GEO. DRAPER & SONS, G. A. Draper, second son of Geo. Draper admitted to the firm.

1880—GEO. DRAPER & SONS, E. S. Draper, third son of Geo. Draper admitted.

1887—GEO. DRAPER & SONS, W. F. Draper, Jr., first son of Wm. F. Draper enters the firm. Geo. Draper the senior member's death occurs in June of same year. Firm name unchanged.

1889—GEO. DRAPER & SONS, Geo. Otis Draper, second son of Wm. F. Draper taken into partnership.

1896—Firm unchanged since 1889.

The present business of the firm consists mainly in the development and introduction of patented improvements on cotton machinery. They manufacture certain of their specialties themselves but devote their main time to the development and introduction of machinery produced by or for the following companies of which they are the sole agents.

THE SAWYER SPINDLE CO.,
President, J. H. Sawyer.
Secretary, Edward Sawyer.
Agent, Wm. F. Draper.

Controlling the sale of
Spindles—Manufactured for the Hopedale Machine Co.
Mason Machine Works.
Fales, Jenks & Co.
Fall River Machine Co.
Lowell Machine Shop.
Saco Water Power Machine Co.
Whitin Machine Works.

THE HOPEDALE MACHINE CO.,
President, Joseph B. Bancroft.
Treasurer, George A. Draper.
Agent, F. M. Day.

Directors, J. B. Bancroft, Wm. F. Draper, Geo. A Draper, E. S. Draper, E. D. Bancroft, F. J. Dutcher, W. F. Draper, Jr., Geo. Otis Draper, G. W. Knight, J. H. Sawyer.

SMTI LIBRARY

Controlling the sale of
Warpers—Manufactured by themselves.
Twisters, " "
Spoolers, " "
Reels. " "
Balling Machines, " "
Speeders, " "
Spooler Guides, " "
Lever Screws, " the Hopedale Machine Screw Co.

THE DUTCHER TEMPLE CO.,
President, Wm. F. Draper.
Treasurer, F. J. Dutcher.
Agent, F. J. Dutcher.
Directors, Wm. F. Draper, F. J. Dutcher, Geo. A. Draper, E. S. Draper, Geo. Otis Draper.
Controlling the sale of
Temples—Manufactured by themselves.

THE NORTHROP LOOM CO.,
President, Wm. F. Draper.
Treasurer, Geo. A. Draper.
Secretary, Geo. Otis Draper.
Directors, Wm. F. Draper, Geo. A. Draper, Eben S. Draper, Wm. F. Draper, Jr., Geo. Otis Draper.
Controlling the sale of their patented
Looms—Manufactured by the Hopedale Machine Co.
" " " Mason Machine Works.
" " " Knowles Loom Works.
" " " Kilburn & Lincoln.
" " " Lewiston Machine Co.
Shuttles, " " Dutcher Temple Co.
Bobbins, " " James Baldwin Co.
Cop Skewers, " " Dutcher Temple Co.
Drop Wires
and Heddles " " Hopedale Machine Screw Co.

THE FIRM OF GEO. DRAPER & SONS,
Controlling the sale of
Spinning Rings—Manufactured by themselves.
Separators, " by the Hopedale Machine Co.
Bobbin Holders, " " " "
Banding Machines, " " " "
Cotton Bale Shears, " " " "
Thin Place Preventers, " " " "
Lifting Rod Cleaners, " " " "
Roving Clamps, " " " "
Chain Dyeing Process, " " " "
Sheet Iron Ring Rails, " " " "

Belt Hole Guards,	Manuf.	by the	Hopedale Machine Co.
Shuttle Guards,	"	"	" "
Cut Markers,	"	"	" "
Spooler Knot Cutters,	"	"	Dutcher Temple Co.
Oil Cans,	"	"	C. B. Getchell.
Bourne Platform,	"	"	Mills using it.

And all the products of the Sawyer Spindle Co., Hopedale Machine Co., Dutcher Temple Co. and Northrop Loom Co.

The business of the firm as shown is not wholly indicative of its past history as it has had control of the introduction of many valuable inventions now ante-dated or passed into other hands. Some of these are as follows:

The Draper Temple.
The Bartlett Let Off Motion.
The Stearns Picker Motion.
The first Shuttle Guards.
The Railway Head Evener.
The Thompson Oil Can.
The Kent Card Guide.
The first self-oiling Spindle Bolsters and Steps.
The first double adjustable Rings.
The Sawyer Spindle.
The Damon Cut Marker.
The Laflin Spooler Guide.
The Inside Catch Shuttle.
The Doyle Separator.

In addition to their main line the firm individually are intimately connected with other Hopedale industries in other lines. They are also interested as directors or stockholders in at least forty cotton mills in various parts of the country.

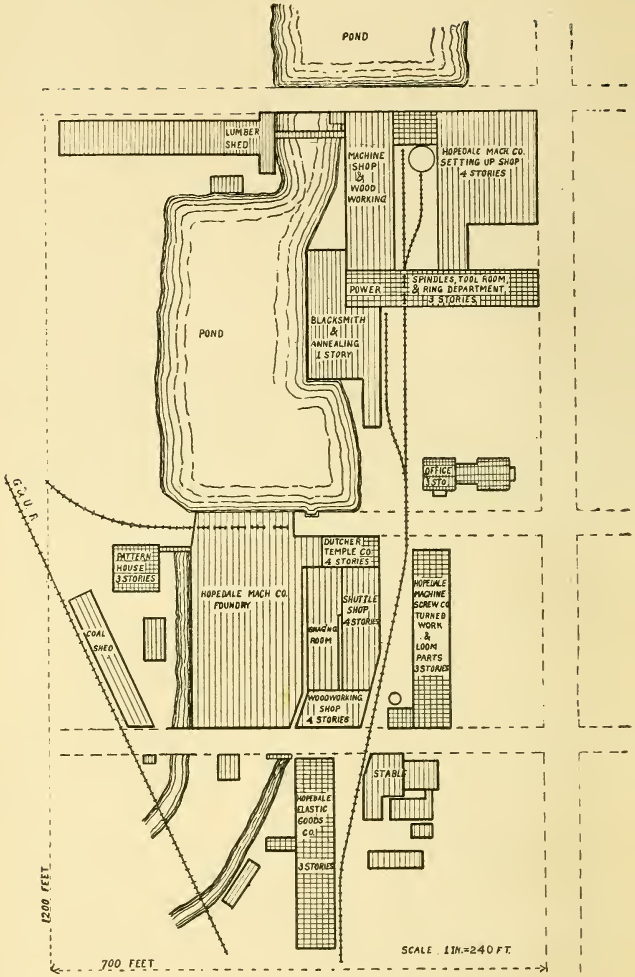
The headquarters of the firm and most of the companies is in the village of Hopedale, Mass. Hopedale is situated at nearly equal distances from Boston, Providence and Worcester. It has train connections on the Grafton & Upton R. R. from Worcester and is reached from the nearest town, Milford, (one mile away) by branches of the Boston & Albany and New England R. R.

Telegrams are to be sent to Milford. We have a long distance telephone.

Visitors are always welcome, and in addition to new features in machinery always in process of development we have the most complete and satisfactory manufacturing village for its size in this country for their inspection.

No mill runs successfully to-day without an equipment of our machinery in the principal lines we manufacture. We doubt if there is a cotton mill in this country which has not some of our machinery in its equipment, or at least machinery embodying our old or new inventions.

In connection with the above statement we would call attention to the fact that machinery of our recommendation usually merits adoption. Skeptics and doubters may not accept our advice at the start, but in the end the inevitable course of competition forces them into the use of our improvements. It needs no lengthy argument to prove that the first users of an invention get the cream of its advantages. We are not infallible, and have sometimes been deceived about the value of a new idea. We try to personally stand the expense of such errors, however, and do not think investigation will discover many of our customers who have suffered financially or permanently through adopting our machinery, or being pioneers with our new devices.


POND
LUMBER SHED
MACHINE SHOP & WOOD WORKING
HOPEDALE MACH CO. SETTING UP SHOP 4 STORIES
POWER
SPINDLES, TOOL ROOM, & RING DEPARTMENT, 3 STORIES
BLACKSMITH & ANNEALING 1 STORY
POND
OFFICE 3 STO
G. & U. R.
PATTERN HOUSE 3 STORIES
COAL SHED
HOPEDALE MACH CO. FOUNDRY
DUTCHER TEMPLE CO 4 STORIES
GRADING ROOM
SHUTTLE SHOP 4 STORIES
WOODWORKING SHOP 4 STORIES
HOPEDALE MACHINE SCREW CO TURNED WORK & LOOM PARTS 3 STORIES
STABLE
HOPEDALE ELASTIC GOODS CO. 3 STORIES
1200 FEET
700 FEET
SCALE 1 IN.=240 FT.

OUR HOPEDALE PLANT.

Our cut on the first page merely shows one half or less o our whole plant. The lower end is still in process of alteration. As shown on the above plan we have twelve acres of floor space. Our foundry is one of the largest in New England.

On the next page we show a photograph of our exhibit at the Atlanta Exposition in the fall of 1895. Our loom attracted much attention there.

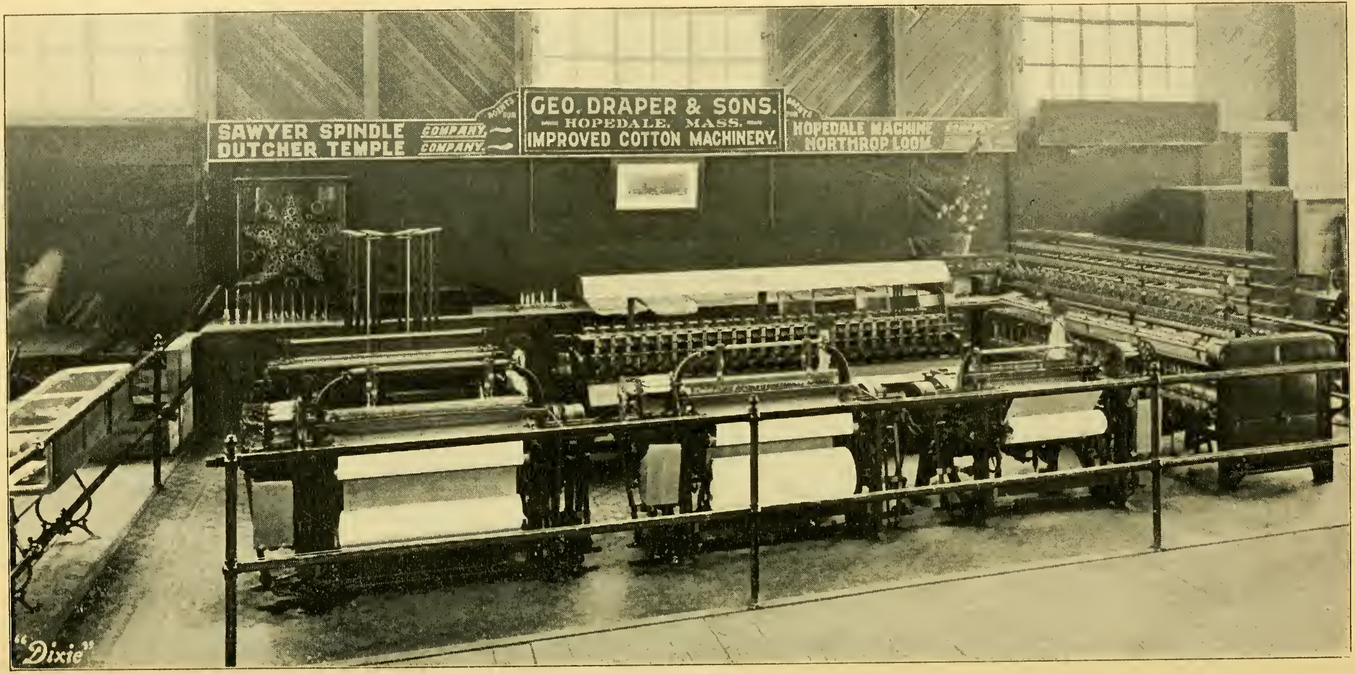

SAWYER SPINDLE COMPANY
DUTCHER TEMPLE COMPANY
AGENTS FOR
GEO. DRAPER & SONS.
— HOPEDALE, MASS. —
IMPROVED COTTON MACHINERY.
AGENTS FOR
HOPEDALE MACHINE
NORTHROP LOOM
"Dixie"

TABLE OF CONTENTS.

PAGE
History 2-16
Cotton Mills 16
Statistics 16-17
Mill Costs 18-19
Cotton 20-21
Opening and Picking . . . 21-24
Carding 24-33
Spinning 34-109

PAGE
Spooling 110-118
Warping 119-137
Chain Dyeing 138-139
Reeling 140-141
Twisting 142-162
Weaving 163-232
Miscellaneous 233-237

INDEX.

PAGE
ACTUAL Humidity . . . 94, 95
  Atmospheric Conditions 27, 94, 95
Avoirdupois Weight . . . 97

BALLING Machine . . 136, 137
  Banding Machine . . . 84, 85
Band Tension . . 59, 85, 91, 233
  Scales 233
Beam Doffer 124
Beams, Warper 125
Belt Hole Guards . . . 234, 235
Bevel Flange Ring 76-77
Bobbin Holder 112
Bobbins 88, 89, 166, 167
Bourne Bobbin Holder . . 112
Bourne Platform 22, 23
Bourne & Johnson Knot Trimmer 113
Breaking Weight of American
    Warp 101
    English Warp . . . 102

CARDERS, Rules for . . 32, 33
  Carding 24-33
Card Clothing 26
Card Room Management . . 27
Carter Oiled Ring 146
Census 13, 17, 222
Chain Dyeing 138, 139
Chain Warper 131-137
Clarke's Balling Machine . 136, 137
Cloth 220, 222-224
Combs, Warper 126
Comparative Numbers of
    Yarn 103-107
Cone Drive 122-124
Cost of Operating Mill, . . 244
Cotton 20
  Bale Shears 21
  Gins 20, 21
  Grades of 20
  Mixing 21-23
  Mills 16, 18, 19
  Opening 23, 24
  Yarn 100
Creel Step 120
Creels, Warper 127
Culver Roving Clamp . . . 80
Cut-Markers 128

DIMENSIONS of Beams . 128
  Circles 97
  Creels 127
  Looms 183, 184, 186
  Reels 140
  Spoolers 117
  Twisters 152
  Walcott Warper . . . 135
  Warpers 127
  Warper Creels . . . 128-135
Double Rings 70-77
Doyle Separators 65
Draper's Evener 62
Draper Spindles 46-51
Drawing-Frames 26
Drop-Wires 121, 167
Durkin's Thick and Thin Place
    Preventer 219-221
Dutcher Temples . . . 193-217
Dyeing 138, 139

ENGLISH Labor Prices . . 237
  English Warp, Breaking
    Weight 102
Evener, Draper's 62
Expansion Reeds and Combs . 126

FAULTS in Cloth . . . 222-224
  Filling, Production of . 63
    Spinning 62-64
Fire Protection 234
French Numbering 100

GETCHELL'S Oil-Can . 236, 237
  Glass Creel Step . . . 120

HARDAKER'S Temple 214-217
  Hetherington Spindle
    Brake 148, 149
Hicks Cone Drive . . . 122-124
Hinge Temple 206, 207
History 2-15
Hopedale Inventors . . 246, 247
  Speeder 25-26
  Spooler 110-118
  Twister 142-154
  Warper 119-130
Humidity 94, 95

PAGE

INVENTIONS . . . 3-5, 8-13
  Inventors . . . 12, 13, 60, 245, 247

JUTE . . . 98

KNOTS . . . 113-115
  Knot Trimmers . . . 113

LANE Tests . . . 238-242
  Lever Screw . . . 81
Licenses . . . 53
Lifting Rod Cleaner . . . 82, 83
Linen Warps . . . 225
  Yarn . . . 98
Linker . . . 134
Long Measure . . . 97
Looms . . . 163-192
Loom Temples . . . 193-217
Low Cylinder Warper . . . 125

MANAGEMENT of Card Room . . . 27
  Spinning Room . . . 90-93
Marking Bands . . . 85
McMullan Spindles . . . 52, 53
Mill Costs . . . 18, 19
Mixing Cotton . . . 21-23

NORTHROP Loom . . . 163-192
  Advantages . . . 172-174
  Earnings . . . 174
  Feeler . . . 170
  Instructions for Running . . . 188-192
  Inventions . . . 171
  Mechanism . . . 164-170
  Patents . . . 176, 177
  Prices . . . 175
  Sales . . . 181
  Shuttles . . . 167
  Warp Stop Motion . . . 168, 169
Northrop Spooler Guide . . . 112
Numbering Roving . . . 28, 29
Numbering Yarns . . . 98-100, 103-107

OIL Cans . . . 236, 237
  Oiling Top Rolls . . . 92
  Spindles . . . 59, 91, 92
Old Frames, altering . . . 89
Opening Cotton . . . 21-24

PATENTS . . . 59, 60, 176, 177
  Pounds of Warp or Filling in Sq. Yd. . . . 227-230
Power . . . 56-59
Price of Double Rings . . . 77
Print Cloths . . . 225
Print Cloth Table . . . 243
Print Works . . . 224
Production of
  Looms . . . 174, 231, 232
  Mills . . . 238-241
  Slasher Warpers . . . 129, 130
  Spindles . . . 61-63
  Spoolers . . . 118
  Twisters . . . 155-157

RABBETH Spindle . . . 41-45
  No. 49 D . . . 41-45
  Parts of . . . 44, 45
Reeds
  Warper . . . 126
Reels . . . 141
Relative Humidity . . . 94, 95
Repairs for Spinning Frames . . . 89

PAGE

Rhoades Chandler Separators . . . 65-69
Rhoades Spooler Chutes . . . 113
Rings . . . 70-78
Ring Frames . . . 86-89
  Holders . . . 71-75
  Manufacture . . . 71-73
  Prices . . . 78
  Rails . . . 78, 79, 145
  Sales . . . 72
  Twister . . . 145, 146
Rolfe Cut-Marker . . . 128
Roving Clamp . . . 80
Roving-Frames . . . 25, 26
Roving, Tables for Numbering . . . 28, 29
  Tables of Twist . . . 30, 31
Rules for Carders . . . 32, 33
  Spinners . . . 96, 97
  Weavers . . . 225, 226

SAWYER Spindles . . . 35-41
  Separators . . . 65-69
Separator Blades . . . 68
Shaw & Flinn's Lifting Rod Cleaner . . . 82, 83
Shears, Cotton-Bale . . . 21
Sherman Spindles . . . 42-43
Sherman Twister Spindle . . . 146, 147
Shuttles . . . 166, 167
Shuttle Guards . . . 218
Silk . . . 98
Slasher Cut-Markers . . . 128
Smith Stop Motion . . . 150, 151
Speakman's Lever Screw . . . 81
Specification for
  Balling Machine . . . 127
  Belt Hole Guards . . . 235
  Lifting Rod Cleaners . . . 83
  Looms . . . 185-187
  Northrop Guides . . . 116, 117
  Oil Cans . . . 237
  Reels . . . 141
  Separators . . . 67, 69
  Shuttle Guards . . . 218
  Spinning-Frames . . . 86-89
  Spoolers . . . 116
  Temples . . . 198
  Twisters . . . 154
  Walcott Warpers . . . 134
  Warpers . . . 127
  Warper Reeds and Combs . . . 126
Speeders . . . 25, 26
Spindles . . . 34-64
  Band Tension . . . 59, 85, 91, 233
  Distribution . . . 247
  Manufacture . . . 55
  Parts . . . 44-45, 50-51
  Patents . . . 59, 60
  Production . . . 61, 63
  Sales . . . 37-41, 54
  Size for different Numbers Yarn . . . 61
  Speed of . . . 61-63
  State of Art . . . 34-36
  Total Number Sold . . . 37
Spinners, Rules for . . . 96, 97
Spinning . . . 34-109
Spinning-Frames . . . 86-89
Spinning Rings . . . 70-78
Spinning Room Management . . . 90-93
Spoolers . . . 110-118
  Bobbin Chutes . . . 113
  Bobbin Holders . . . 112
  Creels . . . 113
  Frame . . . 115

PAGE
  Guides 112
  Knot Cutters 113
  Side Boxes 113
  Spindles 111
  Traverse Motion 115
Spool Raising Device . . . 114
Spring Temple 204, 205
Statistics 13, 17
Stop Motion for Loom . . . 168
  Twister 150
  Warper 121
Straw Chain Dyeing Process 138, 139
Straw Leasing Motion . . . 136
Sullivan Shuttle Guard . . 218

TEMPLES 193-217
  Rolls 194-197
  No. 76 . . . . . . 200, 201
  No. 78 . . . . . . 202, 203
  No. 87 . . . . . . 204, 205
  Hinge 206, 207
  No. 84 . . . . . . 208, 209
  Thread Cutting 210
  Knowles 210-213
  Hardaker 214-217
Tests, Power 56-59
Tests of Mill Machinery . 238 242
Thick and Thin Place Preventers . . . 219-221
Thompson Oil-Can 236
Traveler Clearer 73-76
Twisters 142-157
Twister Brake 148, 149
  Frame 143
  Gearing 143, 144
  Rings 145, 146
  Ring Rails 145

PAGE
  Spindles 146, 147
  Stop Motion 150, 151
  Traverse 149
Twist of Roving 30, 31
Twist Gears for Twisters . . 153
Twist Tables for Cotton Yarn 108, 109
Twisted Yarns 158-162

WADE Bobbin Holder
Wages of English Laborers 235
Walcott's Chain Warper . 131-134
Walmsley Stop-Motion . . 121
Warpers 119-137
Warper Beams 125
  Beam Doffer 124
  Combs 126
  Cone Drive 122-124
  Creels 127
  Low Cylinder 125
  Reeds 126
  Rise Roll 122
  Stop Motion 121
  Tables 129, 130
Watters Improvement on Banding Machine . . 85
Weaving 163-232
Weeks Banding Machine . . 84, 85
Weight of Warp or Filling per Square Yard . . 227-233
Whitin Spindles 52, 50
Wood's Belt Hole Guards . 234, 235
Woolen Yarn 99
Worsted Yarn 99, 100

YARN Reel 140, 141
  Tables 98-108

ADDENDA.

This book was started last fall, and the press has been run continuously to the present time (May 1st, '96.) We have, of course, not been idle meanwhile, and various events occurring since the start, could not be inserted in the proper pages. We now, therefore, add information as follows:

The Northrop Loom Co. has granted licenses to the following loom builders, as the press of orders was too great for the capacity of the Hopedale plant, even after the large additions made last year. These parties can now furnish looms equipped with filling changers and warp stop motions, and can also change over old looms of their manufacture, providing, of course, such alteration is mechanically possible:

The Mason Machine Works of Taunton, Mass.
The Knowles Loom Works, Worcester, Mass.
Kilburn, Lincoln & Co. of Fall River, Mass.
The Lewiston Machine Co. of Lewiston, Me.

We have taken several large orders since compiling the list in the book. One large concern has already applied our warp stop motion to more than 1000 gingham looms, and is steadily increasing the number. It is now too late to assume the conservative position. The results from our looms are more than convincing.

Our other machinery is about the same as shown. We have recently adopted the Woodmancy Doffer Guard on all our Twisters and Spooler Spindles, and it is already found of great advantage. The Straw Chain Dyeing process is now in use in several mills, giving the best satisfaction. One trial has already been followed by an order for the complete mill equipment, and we expect to introduce this system universally on colored work.

Our firm is never free from law suits, the necessary adjunct of a patent business. The latest decision affecting our interests is as follows:

November, 1895.

In the suit of the Sawyer Spindle Company et al. versus Taylor et al., the decision rendered by the Circuit Court of the United States, District of New Jersey, is in favor of the plaintiff. The opinion was filed October 8th, 1895.

This suit is the last of five brought by the Sawyer Spindle Company against infringers of patent to John E. Atwood, No. 253572, dated February 14th, 1882, for Support for Spindles for Spinning Machines. This is one of the foundation patents on high speed spindles, and its claims have been upheld by the courts in every suit in which it has entered. This decision adds one more to the unbroken list of victories in which the Sawyer Spindle Company has triumphed against infringement.

We call attention to this opinion as affecting possible future litigation.

CORRECTIONS.

The error on page 167 has already been referred to on page 179. On page 224 in the list of Print Works, "Gardner & Co." should read "Garner & Co." Outside of this there are several grammatical errors which have been discovered, none of which seem of sufficient importance to delay the issue of the book by re-printing.

PRELIMINARY.

It is our purpose to make this book a compendium of useful information for everyone connected with the manufacture of cotton cloth or yarns. While some of our specialties are equally applicable to Woolen and Worsted manufacture, we feel that the cotton mill is our legitimate field of action and broad enough to require the greater part of our time. In connection with the general information furnished, we introduce descriptions of our machinery, and rules and tables of great interest to the practical manufacturer. These tables in many cases are merely the results of mathematics and formulæ, and have been published by us before. Others, however, are figured from practical results gathered from hundreds of mills, and properly averaged. The latter are of great practical value. In this present edition, new tables are presented whenever the conditions have made such change necessary.

This book is copyrighted and we hope to see that copyright respected. We expect to issue ten thousand at least, and will furnish copies to men occupying responsible positions in mills.

GEO. DRAPER & SONS.

COTTON MANUFACTURING.

As introductory to the general subject, we know of no better general historical sketch than the following extracts from an address of our senior member, Gen. Draper, delivered at the World's Fair in the fall of '93 on the

INFLUENCE OF INVENTION ON COTTON MANUFACTURING INDUSTRIES.

"In considering the subject which has been assigned to me, I do not propose to refer other than briefly to improvements made before the present century; and in fact few improvements had been made over the most self-evident hand processes, up to a hundred and fifty years ago.

This manufacture is one of great antiquity. Herodotus mentions the cotton fabrics of India, and says that the Indian contingent of the Army of Xerxes were clothed in cotton garments.

Theocrastus, a disciple of Aristotle, refers to the cotton plant, and states that its "wool" is woven into cloths, either cheap or of great value.

Alexander's admiral, Nearchus, also mentions the cotton plant, and says that the shirts, mantles and turbans of the people of India were made from it; and Strabo refers to such fabrics as being flowered and beautifully dyed.

Pliny mentions cotton in his natural history, under the name, "gossypium," and states that beautiful garments were made therefrom for the priests of Egypt.

Virgil is considered to have alluded to the cotton plant in the following beautiful lines in the second Georgic:

> " Quid nemora Æthiopum molli canentia lana?
> Velleraque ut foliis depectant tenuia Seres?"

"Shall I sing of the groves of Ethiopia, hoary with soft wool; and how the Seres comb out the delicate fleece from among the leaves?"

Cotton goods were familiar to the Arabs in the time of Mohammed, A. D. 627, and his followers carried the culture of the plant to Spain, where the manufacture of cotton was also introduced; and Columbus, on first landing on American soil, found the natives clad in cotton cloths.

It was, so far as I can ascertain, first mentioned as manufactured in England by Lewis Roberts, in 1641.

Up to the year 1740, however, the manufacture was most primitive. The raw material was cleaned by beating with a stick or cord; the fibres were straightened and brought substantially parallel with each other by hand carding; and each thread was spun singly on the old spinning wheel, though the spindle and distaff were even then largely used.

From the time of Henry the Eighth, up to the date above stated, the spinning wheel was in use in almost every household in England, though the fibres spun were woolen and flax, prior to the introduction of cotton.

The term "spinster," as applied to an unmarried female, arose from the use of this machine.

An expert hand spinner with a spinning wheel, is said by Mr. Chauncy Smith in his "Influence of Inventions on Civilization," to have been able to spin a single thread about four miles long, per day, or eight skeins.

Calling a day twelve hours, which was probably a short day for a hand spinner, each spindle in a Rabbeth frame, on 30s yarn (a very common number), would spin about the same amount; and if the yarn were coarser, more.

A spinner tends to-day a thousand spindles or more, and hence does the work of a thousand spinners with the old-fashioned spinning wheels, not much more than a century ago.

The yarn spun with these wheels was made into cloth, on hand looms, which even at the present time are very imperfect structures, and then were *hand* looms indeed.

Between 1738 and 1780, Paul, Arkwright, Hargraves and Crompton made their wonderful inventions, by which the cotton was carded by a revolving cylinder, and the strands reduced in size by revolving pairs of rollers, each succeeding pair moving more rapidly than the pair which preceded it.

This enabled a number of spindles to be run together in a spinning machine and looked after by one hand, instead of the labor of one person producing only a single thread at a time.

About 1740, the weaving industry was also greatly advanced by the invention of the fly shuttle by Kay. This invention was the practical basis of the power loom, which was invented by Rev. D. E. Cartwright in 1785.

The power loom was further inproved and made more practical by Horrocks, from 1803 to 1813.

These inventions did for weaving what the inventions of Arkwright and others had done for spinning, and the weaving machine for plain fabrics has received only minor improvements since that time.

For figured fabrics there has been a great variety of invention in weaving, which is applicable to other materials besides cotton; and I will therefore only mention the drop box, invented by Kay in 1760, and the invention of Jacquard, which caused a revolution in 1801.

The cotton gin of Elias Whitney, which invention substantially made cotton raising profitable in America, was invented in 1794.

Prior to this a man could pick about four pounds and a half of cotton from the seed in a day. With Whitney's gin a man could separate seventy pounds, or fifteen times as much. Improvements since made have enabled a gin to turn out four thousand pounds a day.

In other words, as in spinning, a single machine will do the work of about a thousand persons.

Following the line of important inventions, the dressing machine for sizing the warps for weaving, and giving them additional strength during that operation, was invented by Johnson and Radcliffe from 1802 to 1804.

The cotton opener with lap attachment, by which, after the dust and seeds were beaten out of the cotton, it was rolled into a continuous sheet called a lap, ready for application to the card, was invented by Creighton in 1814.

In 1816 the self-acting temple for looms was invented by Ira Draper, the grandfather of the author of this paper.

Prior to that, in weaving, the cloth was held extended by clamps, and after two or three inches were woven, the loom was stopped and the clamps reset.

By Mr. Draper's invention the cloth was kept continuously extended, so that these stoppages were saved, and the production and quality of cloth made on power looms, greatly improved.

The self-acting mule, which eliminated what was then known as the hand spinner, was invented by Roberts in 1825.

In 1826 the differential motion for roving frames, is said to have been invented by Houldsworth in England; but it is also claimed that this important improvement was anticipated by Mr. Aza Arnold, an American.

The first patent on ring spinning seems to have been issued to Mr. John Thorpe of Providence, in 1828; while in 1829 Mr. Danforth of Paterson, N. J., invented a spinning machine known as the cap, or Danforth frame, which went into extensive use in cotton manufacture, but is now only used in spinning other fibres.

In the frame of Arkwright and others, up to the invention of the ring spindle, the cotton traveling from the drawing rolls to the bobbin passed around the arm of a flier, which was revolved three or four thousand turns a minute, thus giving twist to the yarn.

Owing to the rapid revolution of these fliers through the air, the amount of power consumed was enormous, and the speed of the spindles was limited to about four thousand turns a minute, because of the tendency of the fliers to spread.

The invention of ring spinning was exceedingly important in the then state of the art, and the ring spinning frame, though greatly improved and doubled in capacity, is the leading spinning machine of to-day.

By doing away with the flier, the power required to drive the machine was greatly reduced, and the speed increased, so that the frame as a whole was much more effective. It was rapidly introduced in America, until in 1860 the great mass of spinning frames in use were ring frames.

In 1841 the drawing frame stop motion, a valuable device for stopping the machine upon the parting of the fibre, was invented by James Smith of Deanston, England.

From this time up to the close of the War of the Rebellion in this country, improvements made were largely matters of adjustment, or overcoming defects in detail in the machines then in use.

Between 1836 and the American Civil War, the following are among the more important inventions introduced, in addition to the ring frame, and drawing stop motion, before referred to—

FIRST: The weft stop motion for looms, which caused the loom to stop whenever the filling broke or was exhausted.

SECOND: The shuttle guard for looms, which prevented the shuttle from leaving the warp and causing personal injury to the weavers. Weavers who had lost an eye from this cause were not uncommon at that date.

THIRD: Let-off motions for looms, by which the amount of yarn to be delivered with each pick of filling was regulated.

FOURTH: The self-stripping device for cards, the invention of Woodman and Wellman, which made a large saving in labor.

FIFTH: The evener for railway heads, and also the evener for openers, which tended to equalize the size of the sheet or strand of cotton at those machines, and hence in the yarn when spun.

SIXTH: Shell rolls, for use in drawing, roving and spinning frames, the invention of Mr. Evan Leigh of England.

At this date, say 1860, a cotton mill seemed to be, and was for the time, a remarkable example of mechanical skill; and the process of converting the cotton in the bale into cloth, was systematized beyond most other manufactures.

The mechanical processes of the cotton manufacture at that time, were,

First: Opening, where the compressed cotton was loosened by being subjected to the action of beaters and fans, and delivered in rolls called laps. This process removed the larger part of dirt and foreign matter.

Next came carding, where the lap was slowly fed against a revolving cylinder covered with leather clothing containing iron teeth, and carried by this cylinder past stationary surfaces also containing teeth, and deposited upon another cylinder called a doffer, from which it was taken off in a thin sheet by a comb—an invention of Arkwright's.

Thence it was delivered into a box upon a belt, which carried the strands from perhaps a dozen cards to what is termed a railway head, where it was reduced in size of strands, by drawing rolls, and subjected to the action of an evener, and delivered into a can.

This process disentangled every tuft or knot, removed most of the remaining seeds, leaf and other dirt, straightened the fibres, and arranged them in parallel order, by laying the cotton first in a fleecy web, and then in a ribbon form.

In the next operation these cans were set up behind a drawing frame, and the strands from them doubled and drawn smaller by the operation invented by Arkwright.

Drawing is a curious contrivance, and is used in the roving and spinning, as well as in the drawing frame. It is an imitation of what is done by the finger and thumb in spinning by hand, and is performed by means of two pairs of rollers. The upper roller of the first pair is covered with leather, which being an elastic substance, is pressed upon the lower roller by means of a spring or weight. The lower roller, made of metal, is fluted, in order to keep a firm hold of the fibres of the cotton. Another similar pair of rollers are placed near to those we have been describing. The second pair moving at a greater velocity, pull the fibres of the cotton from the first pair of rollers. If the surface of the last pair move at twice or thrice the velocity of the first pair, the cotton will be drawn twice or thrice finer than it was. This relative velocity is called draught of the machine.

This operation was repeated from once to three times, until the strand was made as small as it could be without danger of pulling apart in being drawn out of the can.

To enable it to be still further reduced, it was necessary to introduce twist in the next operations. Machines by which this was done, were, and are, called roving machines, and their product is known as roving. These machines, like the drawing frame, draw the cotton still smaller, and, unlike it, communicate twist to it by means of revolving spindles with their fliers.

There was generally two sets of roving machines (to-day the number is increased), and the product of the last was a soft cord of the size required, having a slight twist to give it strength, but not enough to prevent its being "drawn" readily by the rolls of the spinning frame or mule, in making yarn.

This is the last process of the "carding" room, which embraces opening, carding, drawing and roving machinery, and changes the cotton from its crude condition in the bale, into fine, continuous strands, wound upon bobbins ready for spinning.

In a mill where cloth was manufactured, roving was divided in its destination, part for warp and part for filling. The warp yarn was spun with much greater twist, because in the first place, of the extra strength which it required in weaving; and, second, because the less twist of the filling gave a soft appearance to the cloth and was of advantage in dyeing or printing.

The warp yarn was spun upon what are known as ring frames, previously described, which received the roving from the carding room, and converted it into yarn of the size desired.

The reduction in size was made by drawing rolls, as before, and twist was given as in the fly frame, by the rapid revolution of spindles; but in the winding upon the bobbin, the ring and traveller, previously described, were substituted for the flier.

The speed of the spindles of the ring frame was at this time about 5000 revolutions per minute, and the production was, of course, in proportion to this speed.

Following the yarn from the ring frame, where it was wound upon bobbins, it went to the spooler, where it was unwound and rewound upon a spool. As each bobbin was wound off, another was tied on, until the spool was full.

After spooling came warping, in which a large frame, called a creel, was filled with spools, about 200 in number. The "ends" of yarn from each of these spools were drawn together into a flat sheet, which was wound upon a beam, usually about 48 inches long, and 12 inches in diameter. These beams, when full, were taken to a machine called a dresser, where the yarn was run through size and dried over steam pipes, and wound upon a loom beam at the other end of the machine.

The threads were then drawn through loom harnesses and reeds, and the warp was ready for weaving.

Filling was spun upon a machine known as a mule, which drew the yarn to proper size and twisted it, winding it upon the spindle in what are termed cops, of suitable size and shape for use in the shuttle in weaving.

The loom, as before stated, was substantially the machine of fifty years before, having five distinct actions:

First: Raising and lowering, alternately, different sections of warp threads.

Second: Throwing the shuttle between these open sections of warp threads, which are called shades.

Third: Driving up each weft thread to form cloth, after the shuttle is thrown.

Fourth: Unwinding the warp from the beam, ordinarily by means of a let-off motion before referred to.

Fifth: Winding the cloth as fast as made, into a roll.

The ordinary speed of plain looms at this date was about 120 revolutions per minute, while, as before stated, the ordinary speed of spindles was 5000 revolutions per minute.

The machines in the cotton mill of to-day are substantially the same in kind and in function, as those of a quarter of a century ago; but they have been so improved from year to year, that the results, as compared with the former results, are astonishing.

Referring to them, machine by machine, the change in opening machinery has been in the direction of larger production and of carrying away the dust, which at that time filled the rooms where they were run, to the discomfort and injury of health of those employed there.

The production of the card, the next machine, has also been greatly increased, largely by the invention in England of the revolving flat card, in which the flats, instead of being stationary, have a slow motion over the cylinder. This has taken the place in many mills of the cards formerly in use.

Messrs. Foss and Pevey, American inventors, have also greatly increased the production of the old card by nearly doubling the amount of carding surface in the machine.

Where the revolving flat card is used, the railway head before mentioned is eliminated, and the cans from the card are taken direct to the drawing frames.

The drawing frame has been greatly improved in the matter of stop motions, which stop the machine in case either a strand breaks, or has a bunch in it, so that the size of the strand is kept more nearly uniform.

A recent improvement is being introduced, by which pairs of geared metallic rolls draw the fibre in place of a metallic under roll and a leather covered upper roll held upon it by a weight. This is the invention of Mr. Dunham, superintendent of the Merrick Thread mills of Holyoke, Mass.

Roving frames in use have been improved in matters of detail, and in the elevation of the bolster, or upper support for the spindle within the bobbin, which enables the speed of the machine, and consequently its production, to be greatly increased.

In the department of spinning, perhaps the greatest changes have been made.

By the generic inventions of Jacob H. Sawyer of Lowell and Francis J. Rabbeth of Pawtucket, R. I., supplemented by many other minor improvements, the speed of spindles, which is the limit of the produotion of the frame, has been substantially doubled.

The Rabbeth spindle, in some of its forms, is the spindle of to-day; and while it is run from nine to ten thousand revolutions per minute, it can be run at any speed at which the operatives can make good piecings of the yarn which breaks while spinning is going on.

This great increase of capacity of speed was derived by making the spindle bearings loose within small limits, or cushioning them, instead of holding them rigidly, as had previously been done.

The change seems a small one, but the result has been enormous.

As the spindles in use are many millions in number, and as the cost of the spinning machine is about three dollars per spindle, it will be seen that the saving in machinery to produce a given amount of yarn, is very great.

There are more than six million of Rabbeth spindles in use in this country to-day, producing at least as much yarn as ten millions of the spindles of a quarter of a century ago would produce.

It follows that, if the new spindles had not been introduced, more than four million additional spindles of the old kind would have been required to produce the cotton yarn now spun in this country.

The cost of spinning frames, complete, per spindle (as stated above), is about $3. It is estimated that a square foot of floor space is required per spindle to give suitable room for spinning frames and alleys. This costs, at the lowest estimate, 65 cents per square foot. The necessary plant in and for the shafting, heating, lighting, belting, etc., for this room would carry the cost for machinery and room above $4 a spindle. At this figure, therefore, the saving in room, machinery, etc., has been four million spindles at $4 each, or sixteen million dollars.

But this is not all. The old spindles, at 5000 turns, required as much power as the modern spindles at the higher speeds run; hence the power required to drive these four million common spindles, may be counted an entire saving.

At 100 spindles to the horse power (a fair calculation), this would amount to a saving of 40,000 horse power, or more than three water powers like that of Lowell, and worth, at $20 per horse-power per annum (surely a low enough price for steam power in New England), $800,000 each year.

Then, owing to the better running of these spindles, they require no more attention at their high speed than the common spindles at the low speed. The labor cost for spinning, including all employees, from the spinner to the overseer, is, in the best mills, about a cent and one-tenth per spindle per week, or 57 cents a year. The labor saved per annum is therefore above $2,200,000.

Then, again, the old-fashioned spindles required oiling twice a day, while the Rabbeth requires oiling only once in three or four weeks, making a saving that would be counted a large benefit were the other items not so enormous.

Capitalizing all these gains at ten times the annual saving, the advantage to the community by the introduction of the rapidly running spindles is shown by the following figures:

Saving of machinery	$16,000,000
Saving of power	8,000,000
Saving of labor	22,000,000
Making a total of	$46,000,000

Other savings capitalized would doubtless make this an even $50,000,000 in this country alone, while the saving in other countries is doubtless greater, owing to the greater number of these spindles in use.

This is not all. The saving caused by the use of these spindles is found so great in spinning warp yarn, that, in spite of some disadvantages, the ring frame in which they are used is supplanting the mule in spinning filling to a large and increasing extent.

The man who can fully overcome these disadvantages, so that all yarn will be spun upon ring frames, and the mule be eliminated, will be one of the great public benefactors of the next few years.

Successful efforts have been made in this direction in spinning coarse and medium yarns, but the expensive mule is still generally used on the finer numbers.

Besides the improvements in the spindles, there have been other important changes in the spinning room. Among them may be mentioned the double and adjustable spinning ring invented by William T. Carroll of Worcester, Mass.; and the separator, invented by Doyle of Lowell, Mass. These inventions were rendered almost, or quite, necessary, by the increased speed of the machines made possible by Rabbeth.

The spooler, the next machine in order, has been improved by A. M. Wade of Lawrence, Mass., by replacing the spindle for holding the bobbin from which the yarn is being wound, by a box with movable sides, which regulate the tension as desired. The use of this bobbin holder reduces breakage to a minimum, and saves in other directions.

SMTI LIBRARY

Spooler guides, so called, of various forms, have been patented, and introduced, which clean from the yarn some of the motes and bunches that ought to be removed in the carding room, but so far are not.

The next machine, the warper, has been so much revolutionized that it would hardly be known by the side of the machine of twenty-five years ago.

The change arises from the substitution of a much larger beam, holding several times as much yarn, and hence saving waste and piecings in subsequent operations.

This change has rendered necessary the adoption of improved stop motions, which stop the machine whenever one of the several hundred threads being wound upon the beam, breaks.

The stop motion in most general use is a very ingenious device, invented by James Walmsley, and patented about twenty years ago.

A marked increase of production has also been caused by the invention of Mr. Nehemiah Hicks of Sutton, Mass., who, by an automatic attachment, runs the machine faster while the yarn is being drawn from the full spool and is less likely to break, than it is when it is being drawn from the nearly empty spool.

In other words the speed is first regulated by the strain that the yarn from the nearly empty spool will bear, and increased proportionately as the diameter of the yarn on the spools is greater.

The dresser has been replaced by a machine called a slasher, of English invention, which may be said to be the old-fashioned dresser on a large scale, though in most slashers the yarn is dried on copper cylinders filled with steam, instead of over ordinary steam pipes.

A slasher tender will do the work of four or five dresser tenders: hence the saving in cost in this department, by the introduction of the new machine, is very great.

A great improvement in the manufacture of colored work was made a few years ago by Herman F. Straw, agent of the Amoskeag Mills of Manchester, N. H. This invention consists in an improved process for chain dyeing and rewinding, including also an improved machine known as a chain quiller, which winds the yarn from the chain upon filling bobbins, ready for weaving.

The final machine, the loom, has been less changed during the last twenty-five, or even the last fifty, years, than any other machine in the cotton manufacture. It has been increased in speed by fine adjustments of different parts, and devices have been added to prevent thin places in the cloth on the expiration of the filling, and to enable a larger roll of cloth to be wound before removal is necessary.

Substantially speaking, however, the loom of to-day for weaving plain cloth, is the loom of fifty years ago.

The improvement in machinery for the manufacture of cotton cloth has probably been no greater during recent years than the average of improvement in the mechanic arts.

Perhaps it has been less even, because twenty-five years ago cotton was substantially treated automatically, while in many other lines of manufacture hand work prevailed, and invention has since done away with it.

Twenty-five years ago, as to-day, the work of the cotton operative was simply to provide the machines with material in its proper condition to be treated, to remove the finished product, to mend broken strands or yarns, in any of the processes, and to keep the machinery cleaned, oiled, and in working order.

In will be evident, therefore, that the great improvements which have recently been made in this art, have been in making the machines more productive, and adjusting them so as to handle the work with less breakage.

To-day the only real, continuous hand-labor done in the mills, apart from watching the machinery, is the tying of knots by the spooler tender, and the drawing of the warp threads into the harnesses and reeds for weaving. With these exceptions the machines do the work, and the operative watches the machines.

The great inventions of Arkwright and others, which made the cotton manufacture a machine using industry, took place about, or just before, the beginning of the present century, and England is justly proud of them. Since then, however, inventions in this line have been largely American, as shown by the following list, each item of which I have referred to in this article, and which could be enormously increased if minor inventions were to be taken into account :

Cotton gin, Elias Whitney, 1794.

Self-acting loom temple, Ira Draper, 1816.

Differential motion for roving frames, Arnold, about 1820. Claimed also in England.

Ring spinning, John Thorpe, 1828.

Cap spinning, Danforth, 1829.

Weft stop motion, claimed both here and in England.

Shuttle guard, Robbins, in the '50's.

Let-off motion for looms, Bartlett, in the '50's.

Automatic card stripper, Woodman and Wellman in the '50's.

Evener for railway heads, Isaac Hayden, 1851.

Under flat card, Foss and Pevey of Lowell.

Railway head and drawing frame stop motions, some forms invented here and some in England.
Double adjustable spinning ring, Carroll, 1864.
Bobbin holder for spoolers, Wade, in the '60's.
Sawyer spindle, J. H. Sawyer, 1871.
Ring filling frame, George Draper, about 1875.
Separator, Doyle, 1877.
Rabbeth spindle, F. J. Rabbeth, 1878.
Spooler guides, various American inventors.
Geared metalic rolls, Dunham of Holyoke.
Chain quiller, Herman F. Straw, of Manchester, N. H.
Automatic speed changing mechanisms for warpers, N. Hicks.

A few statistics, principally taken from the United States census reports, with brief deductions therefrom, may not be out of place here.

The earliest census report referring to cotton manufactures, was that of 1831. Data earlier than that I have taken from the Memoir of Samuel Slater, the father of the American cotton manufacture, published in 1836.

The capital invested in this industry, was:

In 1831	$ 40,612,984
1850	74,500,934
1860	98,585,269
1870	140,706,291
1880	208,280,346
1890	354,020,843

The value of product is not reported in 1831, but was—

In 1850	$ 65,501,687
1890	267,981,724

The number of spindles in factories were:

In 1790	70
1805	4,500
1810	87,000
1815	130,000
1820	220,000
1827	705,000
1831	1,246,703
1860	5,235,727
1890	14,188,103

The increase from 70 power spindles to upwards of fourteen millions in one hundred years, is certainly phenomenal.

Comparing the census years, the 1831 census, the first, gives 1,246,703 spindles, while the 1890 census gives 14,188.103; and the latter spindles are more than twice as productive. This is an increase of about twenty-four to one in the sixty years.

The capital invested per spindle in mill and machinery, is stated in Slater's Memorial as $35 in 1830, while mills are built to-day equipped with the best machinery, for less than $12 per spindle—it being remembered as before, that the present spindle counts for more than two of the old ones, a reduction in cost of buildings and machinery, effectiveness being considered, of fully six to one.

The number of employees, exclusive of officers and clerks, has increased from 62,208 in the census year of 1831, to 218,876 in 1890.

Hence in 1830 one hand was employed to about twenty slow running spindles, and in 1890 one to about sixty-five rapidly running spindles. Therefore, the production per hand is now about six and one-half times what it was in 1830.

Wages in 1832 averaged, according to Slater's Memorial, $3.63 per week for all employed, men, women and children, and the usual time was thirteen hours daily.

By the census of 1890 the average wages for all cotton mill employees (men, women and children), are stated at $301.65 per annum. Allowing fifty weeks' labor in the year per employee, the average wages per week for all were $6.03. Cotton mills, at least in the East, now run ten hours a day instead of thirteen, and making allowance for the difference in hours, the wages per operative have more than doubled since 1832.

I have at hand no means for comparing prices of the census year in 1832, with present prices, but a bill of Arkwright's in 1784, shows that No. 30's yarn was sold at six shillings and five pence, or about $1.60 a pound.

Samuel Slater in 1800, quotes No. 12 yarn at $1.03, No. 16 yarn $1.19, and No. 20 yarn at $1.36 per pound. The market prices for these yarns to-day are: for No. 12, 13 1-2 cents; for No. 16, 14 cents; for No. 20, 14 1-2 cents, and for No. 30, 18 1-2 cents. And the price of cloths has diminished in like proportion.

It is evident, from these facts, that the improvements in this industry have, first, enormously decreased the cost to the consumer of all cotton goods, they now being not more than one-eighth as costly as one hundred years ago.

In the second place, the number of persons employed has greatly increased, the census figures showing an increase of about three and one-half to one in the last sixty years: and while earlier figures are not attainable, they would doubtless be much more striking.

In the third place, the wages of employees have been doubled within that time, and the figures of Arkwright's time would show a much greater difference.

In the fourth place, an opportunity has been given for the investment of a large amount of capital in productive industry, which is of itself a great public benefit, whoever the capital may be controlled by.

Greater employment, increased wages to the operative, and greatly cheapened commodities for the consumer, have attended these improvements.

The general introduction of improvements in this line, as in other lines, is almost entirely due to the patent system.

Improvements to-day are seldom merely happy thoughts. They are the result of study, and investigation, and experiment, which take time and cost money.

Without the patent system, by which the inventor is able to secure something individually for a successful invention, this time and money would be expended in but few cases.

It may be supposed by some that the self-interest of a manufacturer would cause him to seek for improved processes and machinery, even without the patent system; but this I think would not be the case.

In the first place, the profit to any single mill or manufacturing company, from any of the improvements mentioned in this article, would not be enough to pay the expense of perfecting it, after the original idea had suggested itself. Inventions do not leap full-born from the head of the inventor, but the crude idea has to be licked into shape, and the process is generally long, tedious and costly, if the invention is worth the making.

Second. Without the patent system, any new and successful device introduced into one concern, would soon be copied by others, so that such advantage as might be gained by it at the start would soon be lost.

It is admitted that Americans are the most inventive people of the earth. The records show that they have advanced the cotton manufacture since Samuel Slater's first American cotton mill was started, in Pawtucket, R. I., in 1790, as much as or more than the inventors of all other nations put together.

The reason for this is not that the American is necessarily a man of more ideas or more disposition to study into the laws of nature than other men, but that the patent laws of our country are more favorable to the inventor than those of most other nations.

They offer inducement to thought and study, by protecting the result of that thought and study.

In all changes that may be made in our patent laws from time to time care should be taken to maintain this pre-eminence, so that we may not destroy or lessen the incentives to invention, which, more than any other factor, are responsible for our wonderful material progress during the last one hundred years."

THE COTTON MILL.

As our theme properly includes the mill with the machinery, it is well to start on the ground basis and examine the various incidental features of a properly organized cotton manufacturing plant.

No mill can start until capital has been raised or promised—the former preferably.

Capital is induced to enlist for the following reasons. The general business outlook may be encouraging; the times may favor cheap prices for erection and equipment of plant; some certain locality may offer premiums or promises to such an enterprise; an energetic individual may personally receive backing as the proposed manager; or those furnishing the requisite machinery or real estate may take the stock in exchange. The various combinations of these motives that finally bring about the desired end, are dependent upon the brains of the organizers for success.

The location of a mill is a vital point. It is practically settled that no one thinks of building a coarse goods mill in the North at present. Many think the South will gradually absorb the entire industry. There are good reasons why this may be so. Unquestionably the advantages of cheap cotton, cheap power, cheap labor, long hours, low cost of land and building materials are hard to overcome. The North still has the advantage of a longer acquaintance with the business, larger supply of skilled labor and oversight, accumulated capital and nearness to machinery supplies. Should the North wish to keep the supremacy there must be a change of sentiment among their legislators, many of whom seem to treat manufacturing as an evil which must be restricted and hampered like the liquor traffic. The attitude of the employed to the employer is not always conducive to best results, as there is a growing tendency to hold the manufacturer responsible for every national disaster and its effects on prices.

FIGURES FROM U. S. 1890 CENSUS.

The following table shows the tendency to locate South in the period of 1880 to 1890.

GEOGRAPHICAL DIVISIONS.	NEW SPINDLES.	INCREASE.
	Number.	*Per Cent.*
New England states	2,104,068	24.37
Middle states	242,558	17.44
Southern states	1,011,952	186.69
Western states	76,090	86.33

The tables below show the number of spindles per mill, and the wages paid per spindle. They show conclusively that New England has the advantage of large plants, while the South has cheaper labor.

GEOGRAPHICAL DIVISIONS.	NUMBER OF MILLS.	NUMBER OF SPINDLES.	SPINDLES PER MILL.
New England states	402	10,736,155	26,706
Middle states	239	1,633,722	6,835
Southern states	239	1,554,000	6,502
Western states	24	164,226	6,842

GEOGRAPHICAL DIVISIONS.	WAGES.	WAGES PER SPINDLE.
New England states	$69,489,272	$6.47
Middle states	10,763,873	6.58
Southern states	7,817,069	5.03
Western states	999,739	6.08

We have no hesitation in recommending large-sized mills for economical results. General expense is reduced in various ways, and efficient managers can be utilized. Small mills can not pay for proper supervision, and while many of them are run at a profit, they could all probably be enlarged and make better showings.

As a general rule, consider the cost of running the mill rather than its first cost. In selecting the site study convenience of after management, and leave land space for possible future growth. It is not generally profitable to locate away from a supply of trained help. Freights and taxes should be considered.

DATA.	Common Loom, Frame Filling.	Northrop Loom, Frame Filling.	Common Loom, Mule Filling.	Northrop Loom, Mule Filling.
Number of Looms	1,000	1,000	1,000	1,000
Number of Spindles	36,000	36,000	40,000	40,000
Floor Space	118,000 sq. ft.	118,000 sq. ft.	132,000 sq. ft.	132,000 sq. ft.
COSTS.				
Buildings	$83,000	$83,000	$90,000	$90,000
Power Plant	35,000	35,000	32,500	32,500
Shafting and Belting	14,000	14,000	12,500	12,500
Sprinkling, Heating, Lighting, Plumbing, Supplies	23,000	23,000	24,600	24,600
Preparatory Machinery	77,800	77,800	77,800	77,800
Spinning	108,000	108,000	92,600	92,600
Spooling, Warping and Slashing	8,000	8,000	8,000	8,000
Weaving and Cloth Room	47,000	127,000	47,000	127,000
Incidentals, including Freight, Setting-up, etc	10,000	11,000	10,000	13,000
Total	$405,800	$486,800	$395,000	$478,000
Product per week	288,000 yds. 41,142 lbs.	288,000 yds. 41,142 lbs.	288,000 yds. 41,142 lbs.	288,000 yds. 41,142 lbs.
Investment per pound of product per week	$9.86	$11.82	$9.60	$11.61
Cost per Spindle	$11.27	$14.74	$9.87	$12.91

MILL COSTS.

In order to show what the cost of an average mill figures we have had Mr. F. P. Sheldon, mill engineer of Providence, R. I., estimate on a plant of 1000 looms to run on Print Cloth. Four different estimates are given, as we wished to show the difference between the cost of Northrop loom mills as against common looms, and also the difference between Mule and Frame filling.

This table does not in any way show the difference in cost of running these mills. As this is more important in most instances than the saving in capitalization, we recommend careful perusal of the following pages of this book, where the subject is often referred to.

For instance, the cost of the Northrop loom mills is more than with the common loom. That extra cost, however, makes the mill a heavier dividend payer, and places it beyond the competition of old style mills.

These figures do not include the cost of the mill site, cost of tenements, or cost of cotton. In determining the amount of capital stock necessary for a mill, these items must be considered if the mill expects to start free from debt.

A mill that is built near a source of supplies, will save in freight. Certain machinery has to have extra expense in boxing and setting up when the mill is at a distance. All these things must be considered.

No one should attempt to build a cotton mill without employing a competent engineer. We would recommend the use of the highest talent, as this is a fatal point for economy. It is usually wise to plan the mill so that the power plant can be readily enlarged if additions are ever necessary. Have plenty of light, a good heating system, and efficient moistening apparatus in the various departments where it is necessary.

SELECTION OF MACHINERY.

The gravest errors are possible in this direction. An old mill management should have experience enough to guide them, but a new mill may easily err. Whenever a mill is built by capitalists who have had little experience in cotton manufacturing, it is usually wise to adopt suggestions of the mill engineer, providing, of course, that an expert serves in that capacity.

In cotton machinery, as well as other trades, there are specialists. It is possible to buy an entire mill equipment from single concerns, but we should hesitate in advising such a course. The field is too broad for any one concern to monopolize the best products of every class. Realizing this, we have personally devoted our energies to a few special machines, and are confident that we excel in those lines.

As we will not assume to judge machinery we do not make, we have no recommendation to offer concerning Pickers, Cards, or Spinning Frames. We will guarantee, however, that there can be no mistake made in applying to us for Spoolers, Warpers, Twisters, Reels, Banding Machines, and Looms for plain weaving. Insist on having the Draper Spindle, the Draper Double Adjustable Spinning Ring and the Rhoades Chandler Separator on your spinning frames whoever may be the builder. Be careful to get our latest temples on looms if ordered of other parties.

COTTON.

Grades of cotton:

Ordinary.
Strict ordinary.
Good ordinary.
Strict good ordinary.
Low middling.
Strict low middling.
Middling.
Strict middling.
Good middling.
Strict good middling.
Middling fair.
Fair.

Cotton is purchased by most manufacturers in the shape of a bale. Southern mills in cotton raising sections can have their cotton delivered by team direct from the gin, without going through the compress. In this way they save cost and the greater part of the transportation expense. They also save in the strength of the cotton fibre itself, providing that the process of compression injures the fibre. This, in our mind, is only a theoretical advantage. There is no doubt however but that they get better cotton, being nearer the source of supply and having better opportunities for selection. The process of baling is very imperfect, an American cotton bale being a very slovenly product. In Egypt and India they compress the bales into less space and cover them better. There is plenty of room for improvement here evidently. However the cotton is delivered, it must be ginned after it is picked.

As to the process of ginning, it is supposed to separate the fibre from the seed and leaf. We say it is *supposed* to do so, because the contents of a cotton bale prove that the process is not at all satisfactory. We think the machines are probably overcrowded or speeded too high. There is some discussion going on at present regarding the merits of the roller gin versus the saw gin. The saw gin is said to mangle and tear the fibre in a way which the roller gin may prevent. There is no doubt but there is great chance here for invention, which will gin cotton in such a way as to thoroughly remove all foreign substances without harmful injury to the staple.

While the seed, dirt and leaf which form nearly a tenth of the weight of the usual bale can be extracted in the mill at the picker and card, it is not equitable to have to pay for them at cotton prices.

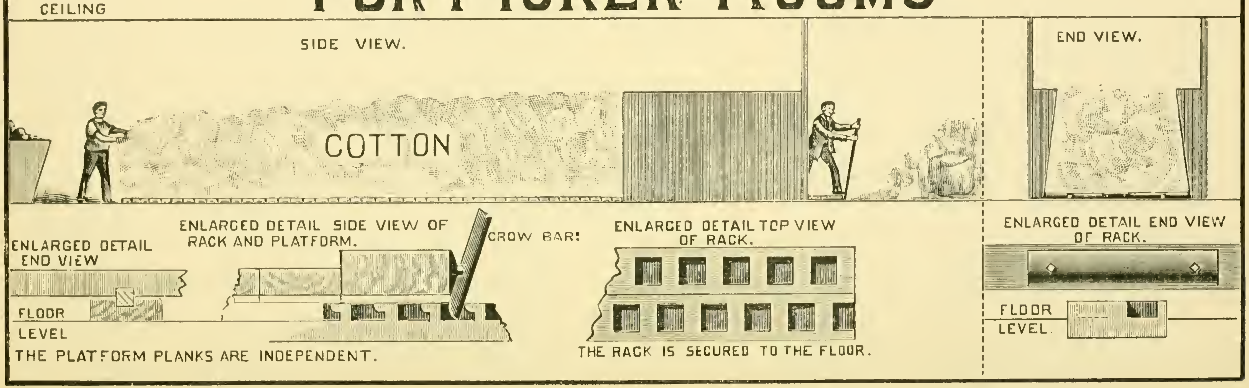
When cotton arrives at the mill in the shape of a bale, it is found necessary to cut ties and loosen up the cotton before use. This may be done in two ways. One method being to pull the bale apart by hand, and the other to pass it through a bale breaker or similar machine which loosens up the cotton by means of beaters. The hand method is probably less liable to damage the cotton, but the question of expense may favor mechanical means.

COTTON BALE SHEARS.

We mentioned that the ties on the cotton bales must be cut. This is accomplished either by means of a common axe or by some form of shears. We have sold different kinds of cotton bale shears for several years, and have introduced no less than three different mechanisms for this purpose. Our latest shear is that first introduced by Mr. John H. Higgins of Woonsocket, and had a very good reputation before we commenced handling it. It is, without doubt, the most satisfactory shear ever devised, and several hundred pairs are already in use. We sell them for $10 a pair. We have to make two sizes, as the bands on Egyptian bales are so wide as to require a different sized cutting blade. In ordering, therefore, specify whether the common or Egyptian bale shear is wanted.

Whatever method of opening bales has been used, it is necessary to thoroughly mix the cotton. This can be done with a mechanical opener, by feeding in from several bales at once. It can, of course, also be done by hand, using proper judgment.

THE BOURNE TRAVELING PLATFORM FOR PICKER ROOMS


CEILING
SIDE VIEW.
COTTON
END VIEW.
ENLARGED DETAIL END VIEW
FLOOR
LEVEL
ENLARGED DETAIL SIDE VIEW OF RACK AND PLATFORM.
CROW BAR:
THE PLATFORM PLANKS ARE INDEPENDENT.
ENLARGED DETAIL TOP VIEW OF RACK.
THE RACK IS SECURED TO THE FLOOR.
ENLARGED DETAIL END VIEW OF RACK.
FLOOR
LEVEL.

BOURNE PLATFORM.

In the usual process of delivering cotton from the bale to the picker, system is almost absolutely lacking and results entirely problematical. While it is known to be beneficial for the later processes to have the cotton well mixed, aired and aged, it is practically impossible under ordinary circumstances without great care and expense. A system that would ensure regular mixing, airing and ageing, has important theoretical possibilities, and the practical results are found to be of great value.

Mr. Stephen N. Bourne of the Stark Mills, Manchester, N. H., has invented and put in application a process which is ideally perfect as regards proper handling of cotton. Besides being of importance as controlling the future processes in keeping the numbers even, it is economical, requiring less help to keep the cotton supplied to the pickers, and is thoroughly systematic.

In line with each Opener Picker or Picker Feeder, is placed a traveling platform on which the cotton is fed. As the cotton is placed on the platform at one end and taken from it at the other, it is evident that the cotton being supplied is always aged by the time it takes to travel from one end of the platform to the other. In the two processes of loading and unloading the platform, the cotton is thoroughly mixed.

The platform as shown in the descriptive cut is simple and easily constructed by an ordinary carpenter. The only casting needed is the rack, which we can supply. The platform is made of separate planks which can be readily handled and moved from one end to the other. One man with a bar can move the entire load of platform and cotton. It is safe to figure about a bale to the foot when estimating the amount of cotton on a platform of the size shown. Details are governed by space which is at hand. The height, breadth or width of the platform and sides can be varied as found necessary.

We would recommend those interested to see the process in operation at the Stark Mills.

We are ready to arrange with those desiring to use this system. We do not superintend the construction, but simply grant a license to use.

OPENING AND PICKING.

In arranging the picker-room, care must be taken for precaution against fire, as the action of the swiftly revolving beaters is very apt to make sparks, providing any metal substance should be fed in with the cotton. Hot bearings can also make trouble, as there are many swiftly revolving shafts in picking machinery. The picking machinery is the heaviest used in the ordinary manufacture of cotton into cloth, and great care must be exercised in setting it up and properly leveling the parts. All revolving shafts should run without cramping, and the beaters should be nicely balanced. It is not necessary to specify details, as only the usual mechanical skill is necessary. Unfortunately, all men who handle machinery are not mechanics in the proper meaning of the word. A little careful oversight therefore will do no harm.

Great improvement has been made in picking machinery in late years. Without going into the various rival processes, it can be stated as a general axiom that the method which cleans the cotton with the least mechanical action, is probably the best.

The use of good modern feeders in the pickers' room will help more toward a thorough opening up and mixing of the fibre than any other single improvement. It will also tend to prevent crowding and make more even laps.

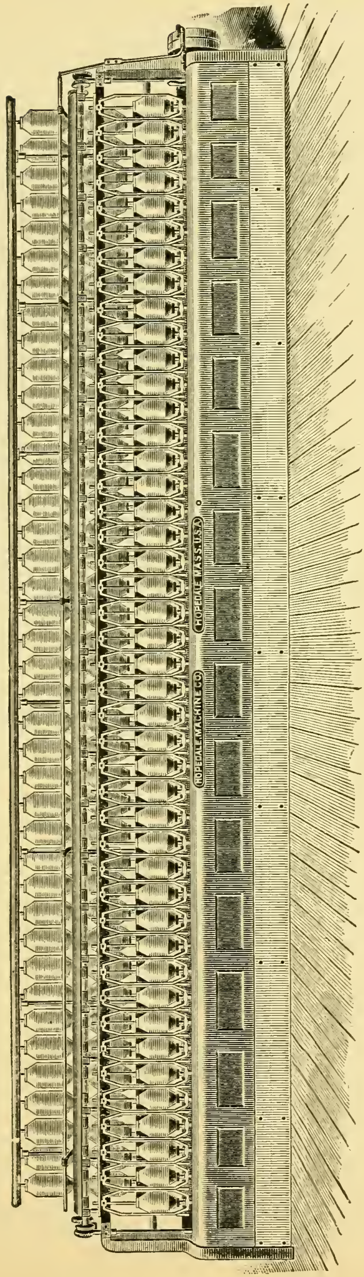
It is of course essential that an even lap be produced. A good clean lap cannot be made on any machine that is crowded, as there is not time or opportunity for dirt and leaf to separate from the fibre. Dirt should be removed from under the beaters with regularity, and cleanliness in this department should be regarded as a virtue of the highest order. Oiling should be attended to by a competent hand, as this machinery is more than usually liable to trouble from dry or hot bearings.

The overseer of this room should be a good manager, and should keep his accumulations of laps regular and not excessive. Picking machinery uses a great deal of air in the various fans, and we have always advised that this air be taken from the interior of the mill itself, rather than from the outside. We see no reason for changing our opinion.

CARDING.

The carding room, as now constituted, contains revolving flat cards, drawing frames, and coarse and fine roving frames or speeders. We say revolving flat cards, because there is no question but that this style of card has superseded all others in this country. While its introduction in America is of rather late date, it has been very rapid. We are glad to note that it is no longer necessary to patronize foreign firms in order to find satisfactory machines. There are now no less than five American builders of this card, and they have shown that native ingenuity can always meet competition on mechanical products.

Drawing frames are very largely used at present, the railway and railway head apparently going out of fashion.


HOPEDALE MACHINE CO.
HOPEDALE MASS. U.S.A.

IMPROVED ROVING-FRAME.

In roving machinery the advance of the past few years has been rather in design and workmanship, than in inventive skill. There is no question but that roving machinery has been greatly improved, but we see no new methods involved.

All the machinery in the carding-room must be substantially set in place and accurately leveled. The floor under the machinery should be protected with galvanized iron having upturned edges. The cards require special attention in setting up and application of the card clothing. While there are many kinds of card clothing in use, there is probably little question as to which are the better grades. It is poor economy to use any other.

Cards should be properly ground before use. Plenty of time should be taken, and this job should be carefully supervised. The more accurately the card is made mechanically, the less will be the necessity for grinding, as it is in this first grinding that all inequalities must be removed.

The revolving card of to-day is a high product of skill and accuracy, and requires intelligent management.

Railway-heads and drawing frames require careful attention in setting up, as there are many nice adjustments to be made; evener-belts must work right, top-rolls be properly covered, drafts correctly arranged, and all moving parts lubricated and the dirty oil wiped off.

Up to this point the sliver has received but little if any twist, and in order to continue its drawing down to yarn it must be twisted as well as doubled and drawn, and in the card-room this is done on what are commonly called Coarse and Fine Speeders and Fly-Frames.

HOPEDALE SPEEDER.

We started to introduce a high-grade Speeder several years ago, and evolved a machine that by reason of its peculiar features and mechanical excellency bid fair to distance competition. The tide was turning, however, from Speeders to Fly-frames, and we were too late to change its course. Moreover we found that the competition between foreign and native builders had brought this class of machinery below the line of fair remuneration. As we could use our tools and room to better advantage, we have never pressed the sale of these machines. Several mills that we equipped, however, have been so pleased with them that they have given us additional orders to increase their plant. If any mill wants the highest grade speeder on the market and is willing to pay the extra cost of extra improvements, we will still continue this branch of our business. Further details and references will be furnished on application.

MANAGEMENT OF THE CARDING-ROOM.

This room is arranged under the usual mill plan; an overseer and second hand being required to supervise the help. It has been found advisable in the arrangement of mills to have a different overseer over each department, so that each one can criticise the others' product and keep him up to the mark.

As in other departments of a mill, crowding should not be allowed in any event. The machinery is designed for certain speeds and productions, and no machine bears overproduction so badly as a card. The clothing is apt to be seriously damaged, and the product affects all the subsequent machinery.

In setting up and starting roving-frames, see that all parts are level and in line, and firmly fixed where they belong; rub the steel rolls lengthwise with whiting and oil on a piece of card clothing. This will take off all the sharp edges and make them run much better. Oil the shells and all roll bearings, and wipe off dirty oil. Run some time before putting work into them. Look out for hot bearings; they damage the machine and are very liable to set loose cotton on fire. Each spindle and flyer wants the same attention in starting that it would have if there were but one to be run instead of thousands. If anything is found broken or damaged so that it will not fill its requirements properly, it should not be tinkered, but thoroughly made good without delay. Careful attention to the covering of the top-rolls will detect any uneven places and save trouble later.

Great attention has been given in late years to providing a proper temperature and moisture in the various parts of the mill; not only for the benefit of the cotton processes, but also for the benefit of the help in hot weather. We do not care to specify any particular plan, but there are several very efficient mechanical means on the market for producing additional air and moisture.

The following tables for numbering roving have been extended and adapted for numbering from weights in tenths of grains. Twist in all cases is 1.20 times the square root of the number.

TABLE FOR NUMBERING ROVING.

12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.
1.	100.00	9.	11.11	16.	6.25	23.	4.35	30.	3.33
.2	83.33	.1	10.99	.1	6.21	.1	4.33	.1	3.32
.4	71.43	.2	10.87	.2	6.17	.2	4.31	.2	3.31
.6	62.50	.3	10.75	.3	6.13	.3	4.29	.3	3.30
.8	55.56	.4	10.64	.4	6.10	.4	4.27	.4	3.29
2.	50.00	.5	10.53	.5	6.06	.5	4.26	.5	3.28
.2	45.45	.6	10.42	.6	6.02	.6	4.24	.6	3.27
.4	41.67	.7	10.31	.7	5.99	.7	4.22	.7	3.26
.6	38.46	.8	10.20	.8	5.95	.8	4.20	.8	3.25
.8	35.71	.9	10.10	.9	5.92	.9	4.18	.9	3.24
3.	33.33	10.	10.00	17.	5.88	24.	4.17	31	3.23
.1	32.26	.1	9.90	.1	5.85	.1	4.15	.1	3.22
.2	31.25	.2	9.80	.2	5.81	.2	4.13	.2	3.21
.3	30.30	.3	9.71	.3	5.78	.3	4.12	.3	3.19
.4	29.41	.4	9.62	.4	5.75	.4	4.10	.4	3.18
.5	28.57	.5	9.52	.5	5.71	.5	4.08	.5	3.17
.6	27.78	.6	9.43	.6	5.68	.6	4.07	.6	3.16
.7	27.03	.7	9.35	.7	5.65	.7	4.05	.7	3.15
.8	26.32	.8	9.26	.8	5.62	.8	4.03	.8	3.14
.9	25.64	.9	9.17	.9	5.59	.9	4.02	.9	3.13
4.	25.00	11.	9.09	18.	5.56	25.	4.00	32.	3.12
.1	24.39	.1	9.01	.1	5.52	.1	3.98	.1	3.12
.2	23.81	.2	8.93	.2	5.49	.2	3.97	.2	3.11
.3	23.26	.3	8.85	.3	5.46	.3	3.95	.3	3.10
.4	22.73	.4	8.77	.4	5.43	.4	3.94	.4	3.09
.5	22.22	.5	8.70	.5	5.41	.5	3.92	.5	3.08
.6	21.74	.6	8.62	.6	5.38	.6	3.91	.6	3.07
.7	21.28	.7	8.55	.7	5.35	.7	3.89	.7	3.06
.8	20.83	.8	8.47	.8	5.32	.8	3.88	.8	3.05
.9	20.41	.9	8.40	.9	5.29	.9	3.86	.9	3.04
5.	20.00	12.	8.33	19.	5.26	26.	3.85	33.	3.03
.1	19.61	.1	8.26	.1	5.24	.1	3.83	.1	3.02
.2	19.23	.2	8.20	.2	5.21	.2	3.82	.2	3.01
.3	18.87	.3	8.13	.3	5.18	.3	3.80	.3	3.00
.4	18.52	.4	8.06	.4	5.15	.4	3.79	.4	2.99
.5	18.18	.5	8.00	.5	5.13	.5	3.77	.5	2.99
.6	17.86	.6	7.94	.6	5.10	.6	3.76	.6	2.98
.7	17.54	.7	7.87	.7	5.08	.7	3.75	.7	2.97
.8	17.24	.8	7.81	.8	5.05	.8	3.73	.8	2.96
.9	16.95	.9	7.75	.9	5.03	.9	3.72	.9	2.95
6.	16.67	13.	7.69	20.	5.00	27.	3.70	34.	2.94
.1	16.39	.1	7.63	.1	4.98	.1	3.69	.1	2.93
.2	16.13	.2	7.58	.2	4.95	.2	3.68	.2	2.92
.3	15.87	.3	7.52	.3	4.93	.3	3.66	.3	2.92
.4	15.62	.4	7.46	.4	4.90	.4	3.65	.4	2.91
.5	15.38	.5	7.41	.5	4.88	.5	3.64	.5	2.90
.6	15.15	.6	7.35	.6	4.85	.6	3.62	.6	2.89
.7	14.93	.7	7.30	.7	4.83	.7	3.61	.7	2.88
.8	14.71	.8	7.25	.8	4.81	.8	3.60	.8	2.87
.9	14.49	.9	7.19	.9	4.78	.9	3.58	.9	2.87
7.	14.29	14.	7.14	21.	4.76	28.	3.57	35.	2.86
.1	14.08	.1	7.09	.1	4.74	.1	3.56	.1	2.85
.2	13.89	.2	7.04	.2	4.72	.2	3.55	.2	2.84
.3	13.70	.3	6.99	.3	4.69	.3	3.53	.3	2.83
.4	13.51	.4	6.94	.4	4.67	.4	3.52	.4	2.82
.5	13.33	.5	6.90	.5	4.65	.5	3.51	.5	2.82
.6	13.16	.6	6.85	.6	4.63	.6	3.50	.6	2.81
.7	12.99	.7	6.80	.7	4.61	.7	3.49	.7	2.80
.8	12.82	.8	6.76	.8	4.59	.8	3.47	.8	2.79
.9	12.66	.9	6.71	.9	4.57	.9	3.46	.9	2.79
8.	12.50	15.	6.67	22.	4.55	29.	3.45	36.	2.78
.1	12.35	.1	6.62	.1	4.52	.1	3.44	.1	2.77
.2	12.20	.2	6.58	.2	4.50	.2	3.42	.2	2.76
.3	12.05	.3	6.54	.3	4.48	.3	3.41	.3	2.75
.4	11.90	.4	6.49	.4	4.46	.4	3.40	.4	2.75
.5	11.76	.5	6.45	.5	4.44	.5	3.39	.5	2.74
.6	11.63	.6	6.41	.6	4.42	.6	3.38	.6	2.73
.7	11.49	.7	6.37	.7	4.41	.7	3.37	.7	2.72
.8	11.36	.8	6.33	.8	4.39	.8	3.36	.8	2.72
.9	11.24	.9	6.29	.9	4.37	.9	3.34	.9	2.71

TABLE FOR NUMBERING ROVING.

12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.
37.	2.70	**48.**	2.08	**65**	1.54	**100**	1.00	**190**	.53
.1	2.70	.2	2.07	.5	1.53	101	.99	192	.52
.2	2.69	.4	2.07	66.	1.52	102	.98	194	.52
.3	2.68	.6	2.06	.5	1.50	103	.97	196	.51
.4	2.67	.8	2.05	67	1.49	104	.96	198	.51
.5	2.67	**49**	2.04	.5	1.48	105	.95	**200**	.50
.6	2.66	.2	2.03	68.	1.47	106	.94	202	.50
.7	2.65	.4	2.02	.5	1.46	107	.93	204	.49
.8	2.65	.6	2.02	69.	1.45	108	.93	206	.49
.9	2.64	.8	2.01	.5	1.44	109	.92	208	.48
38.	2.63	**50.**	2.00	**70.**	1.43	**110**	.91	**210**	.48
.1	2.62	.2	1.99	.5	1.42	111	.90	212	.47
.2	2.62	.4	1.98	71.	1.41	112	.89	214	.47
.3	2.61	.6	1.98	.5	1.40	113	.88	216	.46
.4	2.60	.8	1.97	72.	1.39	114	.88	218	.46
.5	2.60	**51**	1.96	.5	1.38	115	.87	220	.45
.6	2.59	.2	1.95	73.	1.37	116	.86	222	.45
.7	2.58	.4	1.95	.5	1.36	117	.85	224	.45
.8	2.58	.6	1.94	74.	1.35	118	.85	226	.44
.9	2.57	.8	1.93	.5	1.34	119	.84	228	.44
39.	2.56	**52.**	1.92	**75.**	1.33	**120**	.83	**230**	.43
.1	2.56	.2	1.92	.5	1.32	121	.83	235	.43
.2	2.55	.4	1.91	76.	1.32	122	.82	240	.42
.3	2.54	.6	1.90	.5	1.31	123	.81	245	.41
.4	2.54	.8	1.89	77.	1.30	124	.81	250	.40
.5	2.53	**53**	1.89	.5	1.29	125	.80	255	.39
.6	2.53	.2	1.88	78.	1.28	126	.79	260	.38
.7	2.52	.4	1.87	.5	1.27	127	.79	265	.38
.8	2.51	.6	1.87	79.	1.27	128	.78	270	.37
.9	2.51	.8	1.86	.5	1.26	129	.78	275	.36
40.	2.50	**54.**	1.85	**80.**	1.25	**130**	.77	**280**	.36
.2	2.49	.2	1.85	.5	1.24	131	.76	285	.35
.4	2.48	.4	1.84	81.	1.23	132	.76	290	.34
.6	2.46	.6	1.83	.5	1.23	133	.75	295	.34
.8	2.45	.8	1.82	82.	1.22	134	.75	300	.33
41.	2.44	**55.**	1.82	.5	1.21	135	.74	305	.33
.2	2.43	.2	1.81	83.	1.20	136	.74	310	.32
.4	2.42	.4	1.81	.5	1.20	137	.73	315	.32
.6	2.40	.6	1.80	84.	1.19	138	.72	320	.31
.8	2.39	.8	1.79	.5	1.18	139	.72	330	.30
42.	2.38	**56.**	1.79	**85.**	1.18	**140**	.71	**340**	.29
.2	2.37	.2	1.78	.5	1.17	141	.71	350	.29
.4	2.36	.4	1.77	86.	1.16	142	.70	360	.28
.6	2.35	.6	1.77	.5	1.16	143	.70	370	.27
.8	2.34	.8	1.76	87.	1.15	144	.69	380	.26
43.	2.33	**57.**	1.75	.5	1.14	145	.69	390	.26
.2	2.31	.2	1.75	88.	1.14	146	.68	400	.25
.4	2.30	.4	1.74	.5	1.13	147	.68	410	.24
.6	2.29	.6	1.74	89.	1.12	148	.68	420	.24
.8	2.28	.8	1.73	.5	1.12	149	.67	430	.23
44.	2.27	**58.**	1.72	**90.**	1.11	**150**	.67	**440**	.23
.2	2.26	.2	1.72	.5	1.10	152	.66	450	.22
.4	2.25	.4	1.71	91.	1.10	154	.65	460	.22
.6	2.24	.6	1.71	.5	1.09	156	.64	470	.21
.8	2.23	.8	1.70	92.	1.09	158	.63	480	.21
45.	2.22	**59.**	1.69	.5	1.08	**160**	.62	490	.20
.2	2.21	.2	1.69	93.	1.08	162	.62	500	.20
.4	2.20	.4	1.68	.5	1.07	164	.61	525	.19
.6	2.19	.6	1.68	94.	1.06	166	.60	550	.18
.8	2.18	.8	1.67	.5	1.06	168	.60	575	.17
46.	2.17	**60.**	1.67	**95.**	1.05	**170**	.59	**600**	.17
.2	2.16	.5	1.65	.5	1.05	172	.58	625	.16
.4	2.16	61.	1.64	96.	1.04	174	.57	650	.15
.6	2.15	.5	1.63	.5	1.04	176	.57	675	.15
.8	2.14	62.	1.61	97.	1.03	178	.56	700	.14
47.	2.13	.5	1.60	.5	1.03	**180**	.56	725	.14
.2	2.12	63.	1.59	98.	1.02	182	.55	775	.13
.4	2.11	.5	1.57	.5	1.02	184	.54	825	.12
.6	2.10	64.	1.56	99.	1.01	186	.54	900	.11
.8	2.09	.5	1.55	.5	1.01	188	.53	1000	.10

TWIST OF ROVING.

Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.
.10	.316	.38	**.80**	.894	1.07	**2.20**	1.483	1.78	**4.32**	2.078	2.49
.11	.332	.40	.82	.906	1.09	2.22	1.490	1.79	4.36	2.088	2.51
.12	.346	.41	.84	.917	1.10	2.25	1.500	1.80	4.40	2.098	2.52
.13	.361	.43	.86	.927	1.11	2.28	1.510	1.81	4.44	2.107	2.53
.14	.374	.45	.88	.938	1.13	2.31	1.520	1.82	4.48	2.117	2.54
.15	.387	.46	.90	.949	1.14	2.34	1.530	1.84	4.52	2.126	2.55
.16	.400	.48	.92	.959	1.15	2.37	1.539	1.85	4.56	2.135	2.56
.17	.412	.49	.94	.970	1.16	2.40	1.549	1.86	4.60	2.145	2.57
.18	.424	.51	.96	.980	1.18	2.43	1.559	1.87	4.64	2.154	2.58
.19	.436	.52	.98	.990	1.19	2.46	1.568	1.88	4.68	2.163	2.60
.20	.447	.54	**1.00**	1.000	1.20	**2.49**	1.578	1.89	**4.72**	2.173	2.61
.21	.458	.55	1.02	1.010	1.21	2.52	1.587	1.90	4.76	2.182	2.62
.22	.469	.56	1.04	1.020	1.22	2.55	1.597	1.92	4.80	2.191	2.63
.23	.480	.58	1.06	1.030	1.24	2.58	1.606	1.93	4.84	2.200	2.64
.24	.490	.59	1.08	1.039	1.25	2.61	1.616	1.94	4.88	2.209	2.65
.25	.500	.60	1.10	1.049	1.26	2.64	1.625	1.95	4.92	2.218	2.66
.26	.510	.61	1.12	1.058	1.27	2.67	1.634	1.96	4.96	2.227	2.67
.27	.520	.62	1.14	1.068	1.28	2.70	1.643	1.97	5.00	2.236	2.68
.28	.529	.63	1.16	1.077	1.29	2.73	1.652	1.98	5.04	2.245	2.69
.29	.539	.65	1.18	1.086	1.30	2.76	1.661	1.99	5.08	2.254	2.70
.30	.548	.66	**1.20**	1.095	1.31	**2.79**	1.670	2.00	**5.12**	2.263	2.72
.31	.557	.67	1.22	1.105	1.33	2.82	1.679	2.01	5.16	2.272	2.73
.32	.566	.68	1.24	1.114	1.34	2.85	1.688	2.03	5.20	2.280	2.74
.33	.574	.69	1.26	1.122	1.35	2.88	1.697	2.04	5.24	2.289	2.75
.34	.583	.70	1.28	1.131	1.36	2.91	1.706	2.05	5.28	2.298	2.76
.35	.592	.71	1.30	1.140	1.37	2.94	1.715	2.06	5.32	2.307	2.77
.36	.600	.72	1.32	1.149	1.38	2.97	1.723	2.07	5.36	2.315	2.78
.37	.608	.73	1.34	1.158	1.39	3.00	1.732	2.08	5.40	2.324	2.79
.38	.616	.74	1.36	1.166	1.40	3.03	1.741	2.09	5.44	2.332	2.80
.39	.624	.75	1.38	1.175	1.41	3.06	1.749	2.10	5.48	2.341	2.81
.40	.632	.76	**1.40**	1.183	1.42	**3.09**	1.758	2.11	**5.52**	2.349	2.82
.41	.640	.77	1.42	1.192	1.43	3.12	1.766	2.12	5.56	2.358	2.83
.42	.648	.78	1.44	1.200	1.44	3.15	1.775	2.13	5.60	2.366	2.84
.43	.656	.79	1.46	1.208	1.45	3.18	1.783	2.14	5.64	2.375	2.85
.44	.663	.80	1.48	1.217	1.46	3.21	1.792	2.15	5.68	2.383	2.86
.45	.671	.80	1.50	1.225	1.47	3.24	1.800	2.16	5.72	2.392	2.87
.46	.678	.81	1.52	1.233	1.48	3.27	1.808	2.17	5.76	2.400	2.88
.47	.686	.82	1.54	1.241	1.49	3.30	1.817	2.18	5.80	2.408	2.89
.48	.693	.83	1.56	1.249	1.50	3.33	1.825	2.19	5.84	2.416	2.90
.49	.700	.84	1.58	1.257	1.51	3.36	1.833	2.20	5.88	2.425	2.91
.50	.707	.85	**1.60**	1.265	1.52	**3.39**	1.841	2.21	**5.92**	2.433	2.92
.51	.714	.86	1.62	1.273	1.53	3.42	1.849	2.22	5.96	2.441	2.93
.52	.721	.87	1.64	1.281	1.54	3.45	1.857	2.23	6.00	2.449	2.94
.53	.728	.87	1.66	1.288	1.55	3.48	1.865	2.24	6.04	2.458	2.95
.54	.735	.88	1.68	1.296	1.56	3.51	1.873	2.25	6.08	2.466	2.96
.55	.742	.89	1.70	1.304	1.56	3.54	1.881	2.26	6.12	2.474	2.97
.56	.748	.90	1.72	1.311	1.57	3.57	1.889	2.27	6.16	2.482	2.98
.57	.755	.91	1.74	1.319	1.58	3.60	1.897	2.28	6.20	2.490	2.99
.58	.762	.91	1.76	1.327	1.59	3.63	1.905	2.29	6.24	2.498	3.00
.59	.768	.92	1.78	1.334	1.60	3.66	1.913	2.30	6.28	2.506	3.01
.60	.775	.93	**1.80**	1.342	1.61	**3.69**	1.921	2.31	**6.32**	2.514	3.02
.61	.781	.94	1.82	1.349	1.62	3.72	1.929	2.31	6.36	2.522	3.03
.62	.787	.94	1.84	1.356	1.63	3.75	1.936	2.32	6.40	2.530	3.04
.63	.794	.95	1.86	1.364	1.64	3.78	1.944	2.33	6.44	2.538	3.05
.64	.800	.96	1.88	1.371	1.65	3.81	1.952	2.34	6.48	2.546	3.05
.65	.806	.97	1.90	1.378	1.65	3.84	1.960	2.35	6.52	2.553	3.06
.66	.812	.97	1.92	1.386	1.66	3.87	1.967	2.36	6.56	2.561	3.07
.67	.819	.98	1.94	1.393	1.67	3.90	1.975	2.37	6.60	2.569	3.08
.68	.825	.99	1.96	1.400	1.68	3.93	1.982	2.38	6.64	2.577	3.09
.69	.831	1.00	1.98	1.407	1.69	3.96	1.990	2.39	6.68	2.585	3.10
.70	.837	1.00	**2.00**	1.414	1.70	**3.99**	1.997	2.40	**6.72**	2.592	3.11
.71	.843	1.01	2.02	1.421	1.71	4.02	2.005	2.41	6.76	2.600	3.12
.72	.849	1.02	2.04	1.428	1.71	4.05	2.012	2.41	6.80	2.608	3.13
.73	.854	1.02	2.06	1.435	1.72	4.08	2.020	2.42	6.84	2.615	3.14
.74	.860	1.03	2.08	1.442	1.73	4.11	2.027	2.43	6.88	2.623	3.15
.75	.866	1.04	2.10	1.449	1.74	4.14	2.035	2.44	6.92	2.631	3.16
.76	.872	1.05	2.12	1.456	1.75	4.17	2.042	2.45	6.96	2.638	3.17
.77	.877	1.05	2.14	1.463	1.76	4.20	2.049	2.46	7.00	2.646	3.17
.78	.883	1.06	2.16	1.470	1.76	4.23	2.057	2.47	7.04	2.653	3.18
.79	.889	1.07	2.18	1.476	1.77	4.26	2.064	2.48	7.08	2.661	3.19

TWIST OF ROVING.

Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root	Twist, 1.2 × sq. root.
7.10	2.665	3.20	10.62	3.259	3.91	14.84	3.852	4.62	19.76	4.445	5.33
7.15	2.674	3.21	10.68	3.268	3.92	14.91	3.861	4.63	19.84	4.454	5.35
7.20	2.683	3.22	10.74	3.277	3.93	14.98	3.870	4.64	19.92	4.463	5.36
7.25	2.693	3.23	10.80	3.286	3.94	15.05	3.879	4.66	20.00	4.472	5.37
7.30	2.702	3.24	10.86	3.295	3.95	15.12	3.888	4.67	20.08	4.481	5.38
7.35	2.711	3.25	10.92	3.305	3.97	15.19	3.897	4.68	20.16	4.490	5.39
7.40	2.720	3.26	10.98	3.314	3.98	15.26	3.906	4.69	20.24	4.499	5.40
7.45	2.729	3.28	11.04	3.323	3.99	15.33	3.915	4.70	20.32	4.508	5.41
7.50	2.739	3.29	**11.10**	3.332	4.00	**15.40**	3.924	4.71	**20.40**	4.517	5.42
7.55	2.748	3.30	11.16	3.341	4.01	15.47	3.933	4.72	20.48	4.525	5.43
7.60	2.757	3.31	11.22	3.350	4.02	15.54	3.942	4.73	20.56	4.534	5.44
7.65	2.766	3.32	11.28	3.359	4.03	15.61	3.951	4.74	20.64	4.543	5.45
7.70	2.775	3.33	11.34	3.367	4.04	15.68	3.960	4.75	20.72	4.552	5.46
7.75	2.784	3.34	11.40	3.376	4.05	15.75	3.969	4.76	20.80	4.561	5.47
7.80	2.793	3.35	11.46	3.385	4.06	15.82	3.977	4.77	20.88	4.569	5.48
7.85	2.802	3.36	11.52	3.394	4.07	15.89	3.986	4.78	20.96	4.578	5.49
7.90	2.811	3.37	11.58	3.403	4.08	15.96	3.995	4.79	21.04	4.587	5.50
7.95	2.820	3.38	11.64	3.412	4.09	16.03	4.004	4.80	21.12	4.596	5.51
8.00	2.828	3.39	**11.70**	3.421	4.10	**16.10**	4.012	4.81	**21.20**	4.604	5.52
8.05	2.837	3.40	11.76	3.429	4.12	16.17	4.021	4.83	21.28	4.613	5.54
8.10	2.846	3.42	11.82	3.438	4.13	16.24	4.030	4.84	21.36	4.622	5.55
8.15	2.855	3.43	11.88	3.447	4.14	16.31	4.039	4.85	21.44	4.630	5.56
8.20	2.864	3.44	11.94	3.455	4.15	16.38	4.047	4.86	21.52	4.639	5.57
8.25	2.872	3.45	12.00	3.464	4.16	16.45	4.056	4.87	21.60	4.648	5.58
8.30	2.881	3.46	12.06	3.473	4.17	16.52	4.064	4.88	21.68	4.656	5.59
8.35	2.890	3.47	12.12	3.481	4.18	16.59	4.073	4.89	21.76	4.665	5.60
8.40	2.898	3.48	12.18	3.490	4.19	16.66	4.082	4.90	21.84	4.673	5.61
8.45	2.907	3.49	12.24	3.499	4.20	16.73	4.090	4.91	21.92	4.682	5.62
8.50	2.915	3.50	**12.30**	3.507	4.21	**16.80**	4.099	4.92	**22.00**	4.690	5.63
8.55	2.924	3.51	12.36	3.516	4.22	16.87	4.107	4.93	22.08	4.699	5.64
8.60	2.933	3.52	12.42	3.524	4.23	16.94	4.116	4.94	22.16	4.707	5.65
8.65	2.941	3.53	12.48	3.533	4.24	17.01	4.124	4.95	22.24	4.716	5.66
8.70	2.950	3.54	12.54	3.541	4.25	17.08	4.133	4.96	22.32	4.724	5.67
8.75	2.958	3.55	12.60	3.550	4.26	17.15	4.141	4.97	22.40	4.733	5.68
8.80	2.966	3.56	12.66	3.558	4.27	17.22	4.150	4.98	22.48	4.741	5.69
8.85	2.975	3.57	12.72	3.567	4.28	17.29	4.158	4.99	22.56	4.750	5.70
8.90	2.983	3.58	12.78	3.575	4.29	17.36	4.167	5.00	22.64	4.758	5.71
8.95	2.992	3.59	12.84	3.583	4.30	17.43	4.175	5.01	22.72	4.767	5.72
9.00	3.000	3.60	**12.90**	3.592	4.31	**17.50**	4.183	5.02	**22.80**	4.775	5.73
9.05	3.008	3.61	12.96	3.600	4.32	17.57	4.192	5.03	22.88	4.783	5.74
9.10	3.017	3.62	13.02	3.608	4.33	17.64	4.200	5.04	22.96	4.792	5.75
9.15	3.025	3.63	13.08	3.617	4.34	17.71	4.208	5.05	23.04	4.800	5.76
9.20	3.033	3.64	13.14	3.625	4.35	17.78	4.216	5.06	23.12	4.808	5.77
9.25	3.041	3.65	13.20	3.633	4.36	17.85	4.225	5.07	23.20	4.817	5.78
9.30	3.050	3.66	13.26	3.641	4.37	17.92	4.233	5.08	23.28	4.825	5.79
9.35	3.058	3.67	13.32	3.650	4.38	17.99	4.241	5.09	23.36	4.833	5.80
9.40	3.066	3.68	13.38	3.658	4.39	18.06	4.250	5.10	23.44	4.841	5.81
9.45	3.074	3.69	13.44	3.666	4.40	18.13	4.258	5.11	23.52	4.850	5.82
9.50	3.082	3.70	**13.50**	3.674	4.41	**18.20**	4.266	5.12	**23.60**	4.858	5.83
9.55	3.090	3.71	13.56	3.682	4.42	18.27	4.274	5.13	23.68	4.866	5.84
9.60	3.098	3.72	13.62	3.691	4.43	18.34	4.283	5.14	23.76	4.874	5.85
9.65	3.106	3.73	13.68	3.699	4.44	18.41	4.291	5.15	23.84	4.883	5.86
9.70	3.114	3.74	13.74	3.707	4.45	18.48	4.299	5.16	23.92	4.891	5.87
9.75	3.122	3.75	13.80	3.715	4.46	18.55	4.307	5.17	24.00	4.899	5.88
9.80	3.130	3.76	13.86	3.723	4.47	18.62	4.315	5.18	24.08	4.907	5.89
9.85	3.138	3.77	13.92	3.731	4.48	18.69	4.323	5.19	24.16	4.915	5.90
9.90	3.146	3.78	13.98	3.739	4.49	18.76	4.331	5.20	24.24	4.923	5.91
9.95	3.154	3.79	14.04	3.747	4.50	18.83	4.339	5.21	24.32	4.932	5.92
10.00	3.162	3.79	**14.10**	3.755	4.51	**18.90**	4.347	5.22	**24.40**	4.940	5.93
10.05	3.170	3.80	14.16	3.763	4.52	18.97	4.355	5.23	24.48	4.948	5.94
10.10	3.178	3.81	14.22	3.771	4.53	19.04	4.363	5.24	24.56	4.956	5.95
10.15	3.186	3.82	14.28	3.779	4.53	19.11	4.371	5.25	24.64	4.964	5.96
10.20	3.194	3.83	14.34	3.787	4.54	19.18	4.379	5.26	24.72	4.972	5.97
10.25	3.202	3.84	14.40	3.795	4.55	19.25	4.387	5.26	24.80	4.980	5.98
10.30	3.209	3.85	14.46	3.803	4.56	19.32	4.395	5.27	24.88	4.988	5.99
10.35	3.217	3.86	14.52	3.811	4.57	19.39	4.403	5.28	24.96	4.996	6.00
10.40	3.225	3.87	14.58	3.818	4.58	19.46	4.411	5.29	25.04	5.004	6.00
10.45	3.233	3.88	14.64	3.826	4.59	19.53	4.419	5.30	25.12	5.012	6.01
10.50	3.240	3.89	14.70	3.834	4.60	19.60	4.427	5.31	25.20	5.020	6.02
10.55	3.248	3.90	14.76	3.842	4.61	19.67	4.435	5.32	25.28	5.028	6.03

RULES FOR CARDERS.

To determine the number of hanks or decimal parts of hanks to the pound for carding, drawing, slubbing, roving and yarn, according to a given number of yards reeled or measured:—

Multiply the number of yards by $8\frac{1}{3}$ and divide by their weight in grains; the quotient will be the hanks or decimal parts of hanks required.

One yard of No. 1 roving or yarn weighs $8\frac{1}{3}$ grains.

To ascertain what number of yarn will be produced from a given drawing or sliver:—

Measure off a convenient number of yards of sliver, multiply this number by extent of drawing on roving and spinning heads, then multiply by $8\frac{1}{3}$ and divide by the weight in grains, which will give the number of yarn produced from the given sliver. *Example:* Take two yards of sliver weighing 20 grains, and suppose it is to be drawn 5 on roving and 10 on spinning.

$2\times5\times10\times8\frac{1}{3}=833.3,\div20=$No. 41.6, the number of yarn.

To determine what weight a given length of drawing, slubbing, roving or yarn should be to equal a given number of hanks or decimal parts of hanks:—

Multiply the given number of yards in length by $8\frac{1}{3}$ and divide by the number of hanks or decimal parts of hanks required; the quotient will be the weight, in grains, of the given length of drawing, roving or yarn.

To number the yarn produced from roving:—

Reel or measure off a convenient number of yards of roving; multiply this number by extent of drawing on spinning heads. This product multiplied by $8\frac{1}{3}$ and divided by the weight, will give the number of yarn which would be made from the roving. *Example:* Suppose 5 yards of roving weigh 20 grains, and the draught is 10. Then $5\times10\times8\frac{1}{3}=416.6,\div20=20.8$, the number of the yarn.

Given, the weight of lap from the picker, and draught and doublings from the card to the spinning frame: To find the weight at any given point and number of yarn that will be produced:—

Example: Weight of lap, 9 oz.; single carding, draught, 100; railway head, draught, 4; doublings, 14; first drawing, draught, 4, doublings, 3; second drawing, draught, $4\frac{1}{2}$, doublings, 3; slubbers, draught, 4; intermediates, doublings, 2, draught, $5\frac{1}{2}$; fine frames, doublings, 2, draught, $6\frac{1}{2}$; spinning frames, draught, $7\frac{1}{2}$; allowance for flyings and strippings in carding, 12 per cent.; allowance for take up by twist in slubbing, intermediate, fine and spinning frames, $\frac{1}{31}$ each, or about $\frac{1}{7}$ in all; with the following result:—

$9\times437.5=3937.5$ grains in 1 yard of lap.

$3937.5\div100=39.375$ grains in 1 yard after leaving card, were there no loss.

$39.375\times.88=34.65$ grains in 1 yard after deducting 12 per cent. for flyings and strippings.

$34.65\times14\div4=121.27$ grains in 1 yard after leaving railway head.

$121.27\times3\div4=90.95$ grains in 1 yard after leaving first drawing.

$90.95\times3\div4\frac{1}{2}=60.63$ grains in 1 yard after leaving second drawing.

$60.63\div4\times\frac{32}{31}\times12=187.76$ grains in 12 yards after leaving slubbers.

$187.76\times2\div5\frac{1}{2}\times\frac{32}{31}=70.48$ grains in 12 yards after leaving intermediates.

$70.48\times2\div6\frac{1}{2}\times\frac{32}{31}=22.39$ grains in 12 yards after leaving fine frames.

$22.39\div7\frac{1}{2}\times\frac{32}{31}=3.081$ grains in 12 yards after leaving spinning frames.

$3.081\times70=215.67$ grains in 1 hank after leaving spinning frames.

$7000\div215.67=32.45$ number of yarn.

Rule: Multiply the weight in ounces of one yard of lap by 437.5 (grains in an avoirdupois ounce), to reduce to grains; divide by draught of card and multiply by $\frac{88}{100}$ to give weight with allowance for loss in carding; for each successive process, multiply by the doublings and divide by the draught, and on slubbing, intermediate, fine and spinning frames multiply by $\frac{32}{31}$ to allow for increase in weight by twist; at slubbers multiply by 12 for a common number of yards to weigh; and at spinning frames by 70, to give weight per hank, and divide 7000 by the product to determine the number of yarn.

NOTE.—Roving and yarn contract in twisting, and an allowance should be made for this in all computations for a twisted product. This allowance will vary with the number of the yarn and amount of twist put in.

To find the weight of lap required to produce a given number of yarn, and also the weight at any given point, the draught and doublings being known:—

Example: Suppose the draught and doublings the same as in the preceding, and we wish to produce No. 32.45 yarn.

$7000 \div 32.45 = 215.71$ grains per hank.

$215.71 \div 70 = 3.081$ grains per 12 yards.

$3.081 \times \frac{31}{32} \times 7\frac{1}{2} = 22.39$ grains per 12 yards after leaving fine frames.

$22.39 \times \frac{31}{32} \times 6\frac{1}{2} \div 2 = 70.49$ grains per 12 yards after leaving intermediates.

$70.49 \times \frac{31}{32} \times 5\frac{1}{2} \div 2 = 187.78$ grains per 12 yards after leaving slubbers.

$187.78 \times \frac{31}{32} \times 4 \div 12 = 60.63$ grains per 1 yard after leaving second drawing.

$60.63 \times 4\frac{1}{2} \div 3 = 90.95$ grains per 1 yard after leaving first drawing.

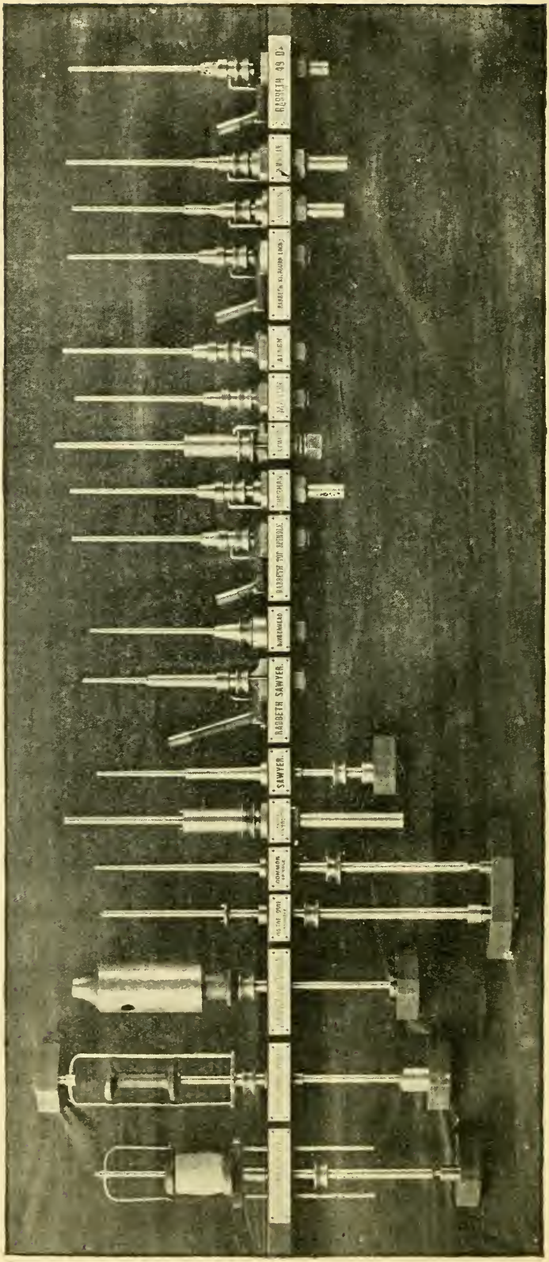
$90.95 \times 4 \div 3 = 121.27$ grains per 1 yard after leaving railway-head.

$121.27 \times 4 \div 14 = 34.65$ grains per 1 yard after leaving card.

$34.65 \times 100 \times \frac{100}{88} = 3937.5$ grains per 1 yard of lap.

$3937.5 \div 437.5 = 9$ ounces per 1 yard of lap.

Rule: Divide 7000 by the number of yarn desired, and that quotient by 70 to give the weight of 12 yards; multiply by the draught of each machine and divide by the doublings; for spinning, fine, intermediate and slubbing frames multiply by $\frac{31}{32}$ to allow for decrease in weight by taking out the twist; at second drawing divide by 12 to give the weight of one yard; multiply by $\frac{100}{88}$ at the card to allow for loss, and divide by 437 5 to give weight of lap required in ounces.


RABBETH 49 D.
ALLEN
RABBETH TOP SPINDLE
BIRKENHEAD
RABBETH SAWYER.
SAWYER.
COMMON SPINDLE

SPINNING.

As illustrative of the state of the art up to our present "Draper" spindle, we show a photograph of models used by Gen. Draper in his address before the New England Cotton Manufacturers at their meeting in April, 1891.

These spindles represent the advance from Arkwright to the above date. They are arranged as follows:

Live Spindle Flier.
Dead Spindle Flier.
Danforth Cap Spindle.
Positive Drive Spindle.
Common Spindle.
Early Rabbeth.
Sawyer.
Rabbeth Sawyer.
Birkenhead.
Rabbeth Top Spindle.
Sherman.
Atwood.
Mayor.
Allen.
Kilburn Lock Rabbeth.
Whitin.
McMullan.
49 D Rabbeth.

Detailed description of these spindles can be had in a pamphlet issued by us in '91, which we will be glad to furnish on application.

Since the advent of the Sawyer Spindle, our firm, as agents for the Sawyer Spindle Co., have controlled the spindle trade by virtue of the superior excellence of the models we have introduced, and at the present time we consider our position stronger than ever before. It is a matter of considerable satisfaction to us to note that in every case of attempted infringement, the spindles introduced against our advice have not only been stamped infringements, but have been universally unsatisfactory in use. We not only claim to control the patents on successful spindles, but also think our experience has taught us mechanical points that no new concern is likely to acquire.

Our spindles are in universal use, simply because they contain undoubted elements of efficiency. We introduced millions of Sawyer Spindles owing to their increased capacity for speed over the Common, and we have supplanted a large proportion of the Sawyer by various forms of the Rabbeth. While the

Sawyer Spindle is now free from patent control, no mill thinks of buying them. In like manner, no one will consider buying the earlier forms of Rabbeth spindle when the patents expire, as our present structures are easily worth more in comparison, than any possible difference in cost.

At the present time the question of speed has been definitely settled. Any of our patented spindles can run at a higher speed than the rest of the frame can stand. The most recent improvements are in the direction of extra smoothness of running, saving in power, and greater convenience. Any one of these is easily worth the profit charged on the whole structure.

The public will probably never realize what has been saved to them by the concentration of the spindle business. Without it there would be dozens of spindles on the market each claiming superiority, and the mills would have to eventually bear the cost of the experiments. With many different spindles there would have been serious complication in the way of repairs and interchangeability. As the case stands, the cost of manufacture has been greatly reduced by having larger orders to work on, enabling the use of special tools and long, uninterupted runs on duplicate parts. This has enabled us to adopt expensive changes without adding to the cost price of the spindle. The present spindle is the most expensive to manufacture of any we have ever introduced. The business has been sufficiently concentrated to enable us to venture on tests and experiments that would, under ordinary circumstances, never have been tried. We have been ready to buy patents without necessarily considering the expense, when chance for improvements was offered. The mills have had the satisfaction of knowing that they would always be held harmless for patent infringement when dealing with us, and that our recommendations could be absolutely relied upon.

So far as the question of our profit is concerned, we have never taken the "Lion's Share," being satisfied with a small percentage of the real gain. We have no doubt but that we could have sold spindles at a much higher price at times, had we wished, as even then the manufacturers would find them sufficiently profitable to warrant their use.

Owing to our conservative course, we are glad to state that our relations with the cotton mills of this country are unusually harmonious, and our position in the trade never so strong. At present we have ended all former litigation, and our relations with other builders are most friendly and satisfactory.

Should any competitor, therefore, appear in the spindle field, we would advise a mill when desirous of trying the new idea to first insist on a satisfactory guarantee against infringement backed by responsible capital; and second, require a guarantee running for a terms of years that will ensure against loss in case of developed defect.

SALES.

Our spindle sales have reached enormous figures, as we have practically controlled the entire spindle business of this country since the introduction of the Sawyer. It may interest our customers to know how these sales are sub-divided.

The totals to July 1, 1895, are as follows:

Sawyer,		3,071,193
Rabbeth Sawyer,		339,808
Rabbeth,—		
Old Rabbeth, about,	1,000,000	
49 Rabbeth, “	300,000	
Sherman, “	600,000	
49 D, “	4,520,221	
		6,420,221
Whitin,		1,658,982
Eureka,		94,612
McMullan, including Buttrick & Flanders		399,311
Boyd, (Twister spindles)		3,784
		11,987,911

The new and old frame business is shown in the following table:

	NEW FRAMES.	OLD FRAMES.
Sawyer,	2,019,996	1,051,197
Rabbeth Sawyer,	82,369	257,439
Rabbeth,	4,619,596	1,800,625
Whitin,	1,345,422	313,560
Eureka,	94,612	....
McMullan,	351,240	48,071
Boyd,	3,604	180
	8,516,839	3,471,072
		8,516,839
		11,987,911

Many Sawyer, Rabbeth Sawyer, and early types of Rabbeth have been replaced by more modern types. Our records only show the cases where these spindles were replaced in the same frame. We have no records showing where new frames of spindles replaced old frames.

In old frames we have replaced 963,614 of our own early types of spindle.

It will be noted that the 49 D is the most popular spindle ever sold in this country. It is very satisfactory to look back and see how all our claims of previous years have been justified.

Regarding sales to special mills, we have so many customers that it would require too much space if we were to show the amounts sold to every mill, as we have done in previous works. We have therefore selected a list of mills with sales of 50,000 or over. Sawyer and Rabbeth Sawyer are grouped and designated by the letter S. All forms of high speed spindle are designated by letter R.

We do not pretend that this list is absolutely correct. It is impossible to keep a straight account involving such multiplicity of figures. If errors are glaring, however, we would be obliged to any mill pointing out a mistake.

This list is complete to July 1st, 1895, and does not include spindles ordered but not billed:

B. B. & R. Knight, Providence, R. I., (All mills under their management.)	71,720 S 234,265 R	305,985
Amoskeag Mfg. Co., Manchester, N. H.,	119,276 S 121,134 R	240,410
Lonsdale Co., Providence, R. I., (Mills at Lonsdale, Ashton, Berkley, Hope, Blackstone and Phenix.)	74,850 S 157,593 R	232,443
Merrimack Mfg. Co., Lowell, Mass.,	97,031 S 102,854 R	199,885
Fall River Iron Works Co., Fall River, Mass.,	178,462 R	178,462
Pacific Mills, Lawrence, Mass.,	28,256 S 137,936 R	166,192
Wamsutta Mills, New Bedford, Mass.,	28,896 S 118,047 R	146,943
Clark Thread Co., Newark, N. J.,	14,742 S 123,937 R	138,679
Tremont and Suffolk Mills, Lowell, Mass.,	63,638 S 65,972 R	129,610
Harmony Mills, Cohoes, N. Y.,	71,104 S 54,001 R	125,105
Boott Cotton Mills, Lowell, Mass.,	66,817 S 40,421 R	107,238
Durfee Mills, Fall River, Mass.,	106,463 R	106,463
Sagamore Mfg. Co., Fall River Mass.,	29,171 S 75,744 R	104,915

Social Mfg. Co., Woonsocket, R. I.,	34,288 s 69,049 R	103,337
Potomska Mills Corp., New Bedford, Mass.,	50,080 s 49,068 R	99,148
King Phillip Mills, Fall River, Mass.,	44,220 s 53,700 R	97,920
Dwight Mfg. Co., Chicopee, Mass.,	28,815 s 68,064 R	96,879
Pepperell Mfg. Co., Biddeford, Me.,	94,784 R	94,784
Willimantic Linen Co., Willimantic, Conn.,	5,200 s 88,576 R	93,776
Stark Mills, Manchester, N. H.,	56,906 s 36,192 R	93,098
Hamilton Mfg. Co., Lowell, Mass.,	87,768 s 8,742 R	96,510
Bennett Mfg. Co., New Bedford, Mass.,	87,832 R	87,832
Grosvenor Dale Co., North Grosvenor Dale, Conn.,	33,720 s 52,784 R	86,504
Cocheco Mfg. Co., Dover, N. H.,	70,198 s 16,192 R	86,390
Pocassett Mfg. Co., Fall River, Mass.,	25,972 s 60,321 R	86,293
Union Cotton Mfg. Co., Fall River, Mass.,	42,576 s 41,840 R	84,416
Massachusetts Cotton Mills, Lowell, Mass.,	29,137 s 54,931 R	84,068
Merchants Mfg. Co., Fall River, Mass.,	25,725 s 57,280 R	83,005
Chicopee Mfg. Co., Chicopee Falls, Mass.,	43,392 s 39,573 R	82,965
Nashua Mfg. Co., Nashua, N. H.,	48,886 s 31,694 R	80,580
Hamilton Woolen Co., Amesbury, Mass.,	5,776 s 72,248 R	78,024

Everett Mills, Lawrence, Mass.,	32,544 s	
	44,653 r	77,197
Great Falls Mfg. Co., Somersworth, N. H.,	77,100 r	77,100
Lancaster Mfg. Co., Clinton, Mass.,	32,606 s	
	44,023 r	76,629
Lawrence Mfg. Co., Lowell, Mass.,	6,624 s	
	69,137 r	75,761
City Mfg. Corp., New Bedford, Mass.,	75,030 r	75,030
Otis Co., Ware, Mass.,	26,432 s	
	46,644 r	73,076
Granite Mill, Fall River, Mass.,	19,680 s	
	52,980 r	72,660
Acushnet Mill Corp., New Bedford, Mass.,	71,993 r	71,993
Globe Yarn Mills, Fall River, Mass.,	6,000 s	
	63,865 r	69,865
Arlington Mills, Lawrence, Mass.,	19,216 s	
	50,526 r	69,742
Edwards Mfg. Co., Augusta, Me.,	19,516 s	
	49,954 r	69,474
Border City Mfg. Co., Fall River, Mass.,	9,180 s	
	59,820 r	69,000
Ponemah Mills, Taftville, Conn.,	14,273 s	
	54,304 r	68,577
Osborne Mills, Fall River, Mass.,	4,352 s	
	60,384 r	64,736
Seaconnet Mills, Fall River, Mass.,	62,857 r	62,857
Stafford Mills, Fall River, Mass.,	61,440 r	61,440
U. S. Cotton Co., Central Falls, R. I.,	60,162 r	60,162
Hargreaves Mills, Fall River, Mass.,	59,128 r	59,128
Chace Mills, Fall River, Mass.,	6,270 s	
	51,290 r	57,560
Wampanoag Mills, Fall River, Mass.,	32,956 s	
	24,662 r	57,618

Appleton Co., Lowell, Mass.,	35,276 S	18,482 R	53,758
Bates Mfg. Co., Lewiston, Me.,	828 S	52,120 R	52,948
Pacolet Mfg. Co., Pacolet, S. C.,		52,924 R	52,924
American Linen Co., Fall River, Mass.,	45,584 S	7,152 R	52,736
Manchester Mills, Manchester, N. H.,	22,016 S	30,536 R	52,552
Naumkeag Steam Cotton Co., Salem, Mass.,	11,744 S	40,789 R	52,533
Lyman Mills, Holyoke, Mass.,	42,176 S	9,744 R	51,920
Amory Mfg. Co., Manchester, N. H.,		51,761 R	51,761
Hadley Company, Holyoke, Mass.,	14,672 S	36,099 R	50,771
Howland Mills Corp., New Bedford, Mass.,		50,490 R	50,490
Bristol Mfg. Corp., New Bedford, Mass.,		50,176 R	50,176
Fall River Manufactory, Fall River, Mass.,		49,266 R	49,266

THE 49 D SPINDLE.

Although superseded by an improved form to-day, the 49 D Spindle marks a turning point in the spindle industry quite as distinct as any of its predecessors. The first Rabbeth spindles developed serious defects that threatened their supremacy. They would bear high speed, but would not stay central in the ring, and their packings wore out badly. Wear induced vibration, and they took a large relative amount of power. In some types the oiling feature was imperfect, and many mechanical details were unsatisfactory.

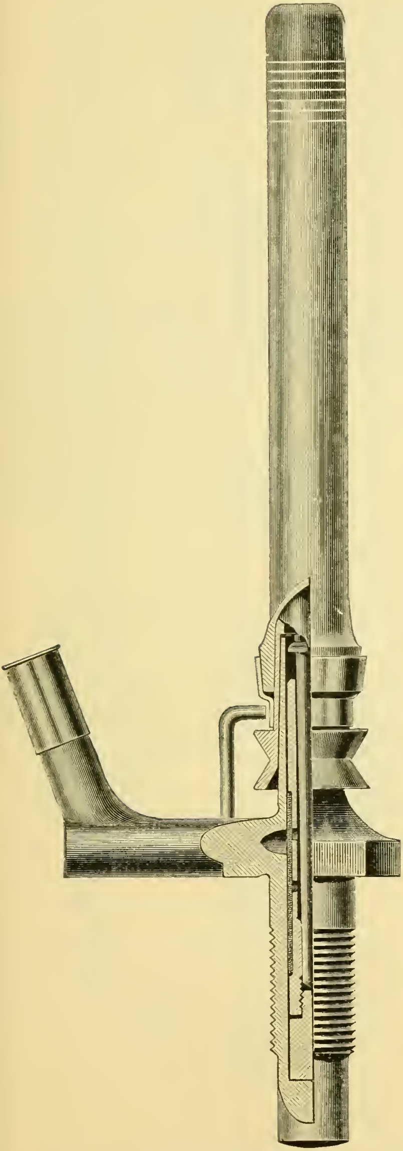
The 49 D Rabbeth Spindle started with a distinct novelty in the shape of a taper bearing made adjustable for wear by a screw step. Taper bearings had been tried before on account of the smaller consumption of power, but the effects of wear were disastrous. During a series of power tests in 1888 the mechanical features of the structure were greatly improved, and the standard model was placed on the market in the fall of that year. Without scarcely a perceptible change this spindle has held the market for seven years, and its total sales eclipse any former record of any one type of patented spindle.

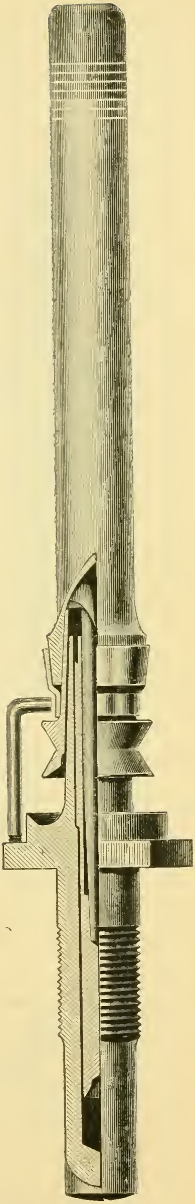
It was shown by accurate power tests that the 49 D spindle required less power than any other spindle known. We never heard this point questioned. Its steadiness of running was remarkable, and no other spindle ever had such uniformity of excellence. In durability it exceeded our expectations, and as no other spindle had the capacity for taking up wear, we were not afraid of comparison with other types. In general details it has proved convenient and requiring little attention. The packings do not wear out like the older types.

Referring to the cut, the inside structure can be noted. The taper bearing reduces power, and strengthens the blade where strength is needed. The long bearing enables a greater looseness in the fit, saving in power and steadiness. The flat step saves in wear, as a pointed step is apt to act like a drill, if oil is ever absent. The long cylindrical head on the bolster enables a definite fit to be gauged. The packing is securely held in place, and as the bolster is limited in movement at both ends, no harmful pressure can wear it out. The two locking pins hold the bolster and step from turning, except when adjustment is necessary. The bolster is then raised from contact with the upper pin and turned on the screw step to tighten or loosen the bearing. The notches provide for a quarter turn adjustment. The oiling arrangement has the old projecting snout, which holds a large supply, and keeps it opposite the upper bearing where it is most needed. As the bolster is some distance below the top of the base, very little oil can fly out. The bobbin is driven by the usual whorl and cup. We have never found anything better.

THE SHERMAN SPINDLE.

This spindle has been extensively used on spinning, and is also our standard for Twisters. It has a combined bolster and step, being very similar to the Whitin. The bolster is supported midway, and has no packing.





49 D Rabbeth Spindle, Sherman Spindle.
Exterior partly exposed.

REPAIR PARTS FOR 49 D SPINDLE.

On account of the immense number of 49 D Spindles in use, we illustrate the parts to facilitate orders for repairs:

No. 1—Is the spindle proper, with Whorl and Cup. We can also supply the new blade shown in the "Draper" Spindle cut with orders for 49 D spindles whether new or on repair lots. It will have to be specified in the order.

No. 2—Is the Brass Collar, which is forced on the Spindle to prevent the oil from rising and flowing out over the outside of the case.

No. 3—Is the Bobbin supporting Cup.

No. 4—Is the Base.

No. 5—Is the Cap for oil reservoir.

No. 6—Is the Retaining Hook.

No. 7—The Bolster.

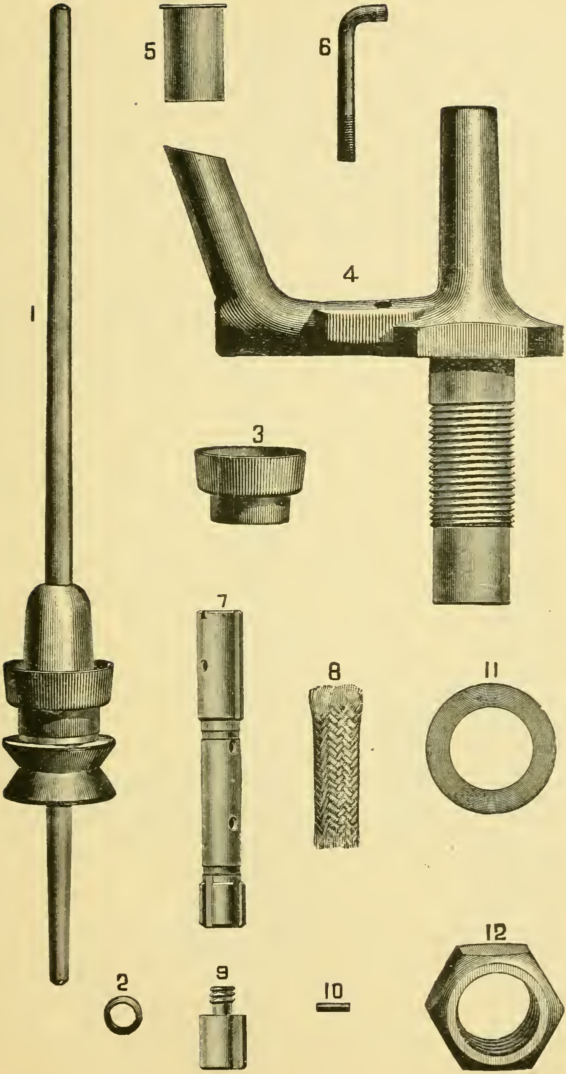
No. 8—The Packing.

No. 9—The Step.

No. 10—The Pin, of which there are two—one for holding the Step, the other for holding the Bolster in place.

No. 11—Is the Washer.

No. 12—The Nut.



Parts of 49 D Spindle,
Illustrated and named.

THE DRAPER SPINDLE.

The 49 D Spindle has been our standard type for seven years. It has won a place entitling it to confidence and esteem, and it is safe to say no other spindle ever met with such universal commendation. It is now the recognized leader in its class, monopolizing the greater proportion of total sales, and seemingly beyond criticism in its main features

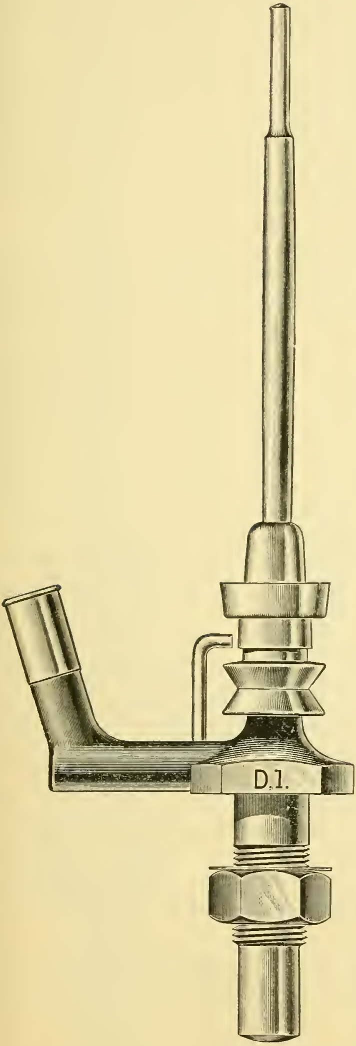
It takes a rash experimenter to try improvement on such a model. It is doubtful if advance were even thought necessary until the change in modern requirements presented new possibilities.

The general conversion of bright mill management to the large ring and long traverse idea, brought with it the demand for spindles that would stand the additional strain and load. The natural result would be the use of a larger, stronger spindle, such as the 81 D (large 49 D) or Medium Whitin. Such was our former recommendation.

We have lately introduced a spindle on the same general line as the 49 D,but have so proportioned its parts as to enable it to be used on heavier work. The main change is in the spindle shaft, which is scientifically proportioned so as to obtain a maximum strength at the weakest bending section. This shaft was designed by Gen. Draper, and its peculiar shape has been patented to prevent infringement. The spindle has the same size of bearing in the bolster as the 49 D, and so consumes no more power. In fact its more than doubled stiffness, by preventing any cramping or vibrating, actually shows quite a saving in power.

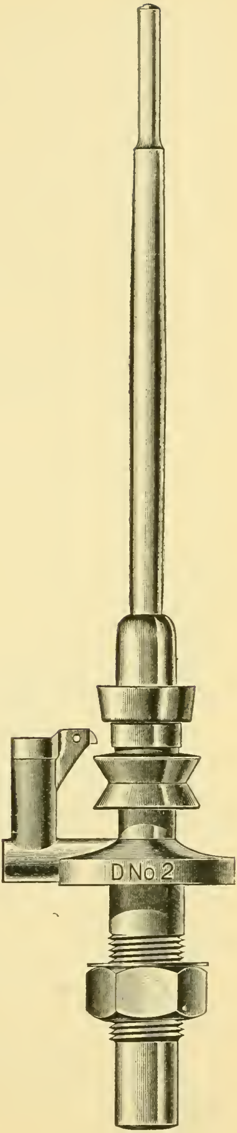
The use of this spindle shows a gain of twenty per cent. in power over the use of a heavy spindle like the 81 D, the large-size Rabbeth. As it can be used on most of the work formerly requiring the heavy spindle, the gain is very considerable. To say nothing of the power, the increased cost of the heavy pattern is ten cents per spindle, which shows how a very appreciable saving can be made at the outset.

Another improvement of no small importance, is a change in the adjustment feature of the bearings. The former method of locking the bolster from turning by a rigid pin had disadvantages, as the peculiar operation of a loose bolster, as affecting the steadiness of running the spindle, was hampered by the fixed position of the lock. The new method connects the bolster and step by a spiral spring in addition to the usual screw thread. The spring not only furnishes a yielding connection, adding greatly to the smoothness of running of the spindle, but also provides a means for the spindle to adjust its



DRAPER NO. 1

As shown in cut, has Large Cup and Short Traverse Blade. Can have Small Cup and Long Blade when desired.



DRAPER NO. 2

As shown in cut, has Small Cup and Long Traverse Blade.

own fit while running. Should the spindle be too tight in its bearing, it will turn the bolster against the spring in the direction of its rotation. This will also turn it downwardly on the screw step, and thus loosen itself by reason of the taper bore of the bearing. Conversely if the bolster be too loose, the spring will tend to take up the looseness. Should the spindle be either abnormally tight or loose, it can be easily adjusted by moving the spring in the notches provided for its locking end. This spring connection is patented by Mr. F. M. Day, our spindle contractor. The screw step connection yet retains the elements of the patent to Wm. F. & Geo. A. Draper.

A third novelty of considerable importance is the adoption of the Woodmancy Doffer Guard, and Oil Tube Cover. The trade is already familiar with this device from its use on recent orders for Whitin Spindles, and the test of its use fully warrants its adoption.

The Woodmancy device not only furnishes a most efficient means for locking the spindle and liberating the same without use of tools, but by its position, in connection with the oil tube, affords new posibilities in the way of cheap and efficient oiling. The oil tube is constructed to project in front of the spindle, instead of behind it, and thus offers easy means for oiling, free from former difficulties. The position of the Doffer Guard with relation to the band prevents any possibility of a loose band rising and spoiling the yarn by rubbing on the bobbin.

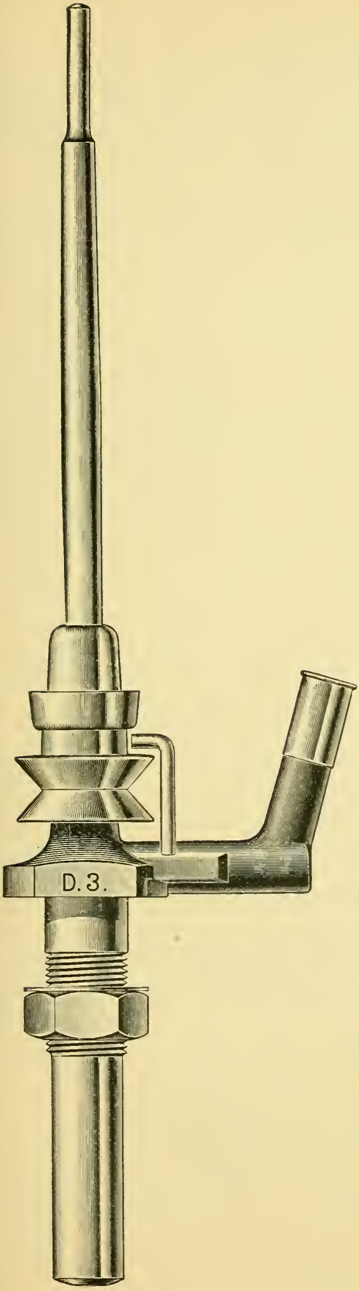
Although our new spindles are more expensive to manufacture, and much more efficient for certain uses, we make no extra charge for their advantages.

As the common oil snout has gained a host of friends who may be loth to change their views, we still shall continue it as a regular form. It has the advantage of holding the oil higher than is possible with the Woodmancy device, and the disadvantages of unhandiness for oiling and inconvenience in taking out spindles.

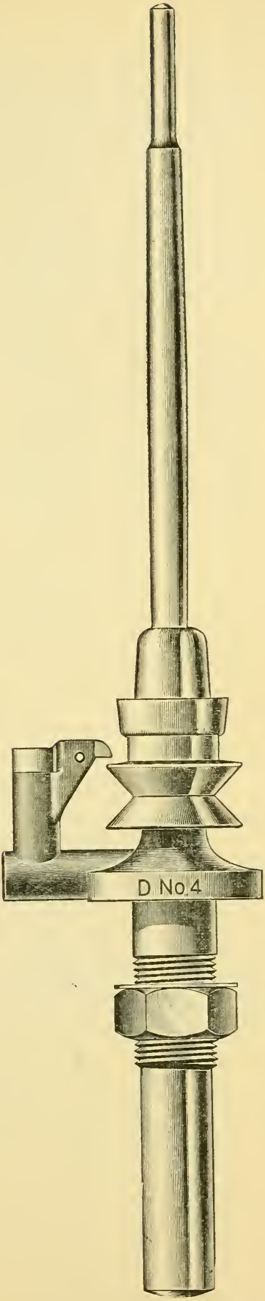
We call our new spindle the "Draper," as there are more Draper patents included in its design than of any other one inventor.

When ordering bobbins for use with this spindle, take notice that the spindle blade, being larger than formerly, may require a larger internal bore. This applies especially to filling bobbins.

Manufacturers who saw samples of this spindle before any large number had been in use, placed orders for over half a million of them. We make no hasty judgment in recommending it, as we have tested the main features for several years.



DRAPER NO. 3.
One length Blade and one size Cup.



DRAPER NO. 4.
One length Blade and one size Cup.

This spindle is adapted for all work up to and including two inch ring and seven inch traverse. We would prefer to recommend a larger size spindle for work beyond these limits.

We designate our different types as follows, as shown in the cuts, which are one-half size:—

DRAPER NO. 1.—NO. 2.—NO. 3.—NO. 4.

DRAPER NO. 1 has regular base, Draper blade, either traverse, either large or small cup.

DRAPER NO. 2 has Woodmancy base, Draper blade, either traverse, either large or small cup.

LARGER SIZES.

DRAPER NO. 3 has regular base, Draper blade, one length, one size cup.

DRAPER NO. 4 has Woodmancy base, Draper blade, one length, one size cup.

With DRAPER NO. 1 and NO. 2 the short blade for 5½ inch traverse has a ¾ inch whorl. The longer blade for 6 inch traverse and above, has a 13-16 whorl. These sizes have been set by experience, which has shown that the larger whorl was necessary for the longer spindle. When traverse is over 6 inches the bobbin should be lengthened above the spindle.

Spindles should be ordered as follows:—

Name of spindle as DRAPER NO. 2.	
Length of traverse as	6½ inches.
Style of cup as	small cup.

When spindles are to be used to spin filling for Northrop Loom, the cup should be of the regular warp or small size.

PARTS OF DRAPER SPINDLE.

TECHNICAL NAMES.

BLADE—with whorl, cup and oil collar. These parts are never sold separately, as they cannot be united properly except with our special tools. Specify whether long or short blade is desired. Short blade is for 5½ traverse, or less. Long blade takes six inch traverse and above. Also specify large or small cup. Large cup is used on old style filling bobbins, and for large diameter warp bobbins such as many are using with large rings and long traverse. Small cup is used on ordinary warp bobbins. and on filling bobbins intended for use with Northrop looms.

BASE—Specify whether Draper No. 1, 2, 3 or 4. Also specify whether long or short blade is to go with it, when No. 2 base is ordered.

BOLSTER—one size for No. 1 and 2; larger for 3 and 4.

PACKING—one size for No. 1 and 2; larger for 3 and 4.

SPRING—one size for No. 1 and 2; larger for 3 and 4.

STEP—one size for No. 1 and 2; larger for 3 and 4.

NUT—one size for No. 1 and 2; larger for 3 and 4.

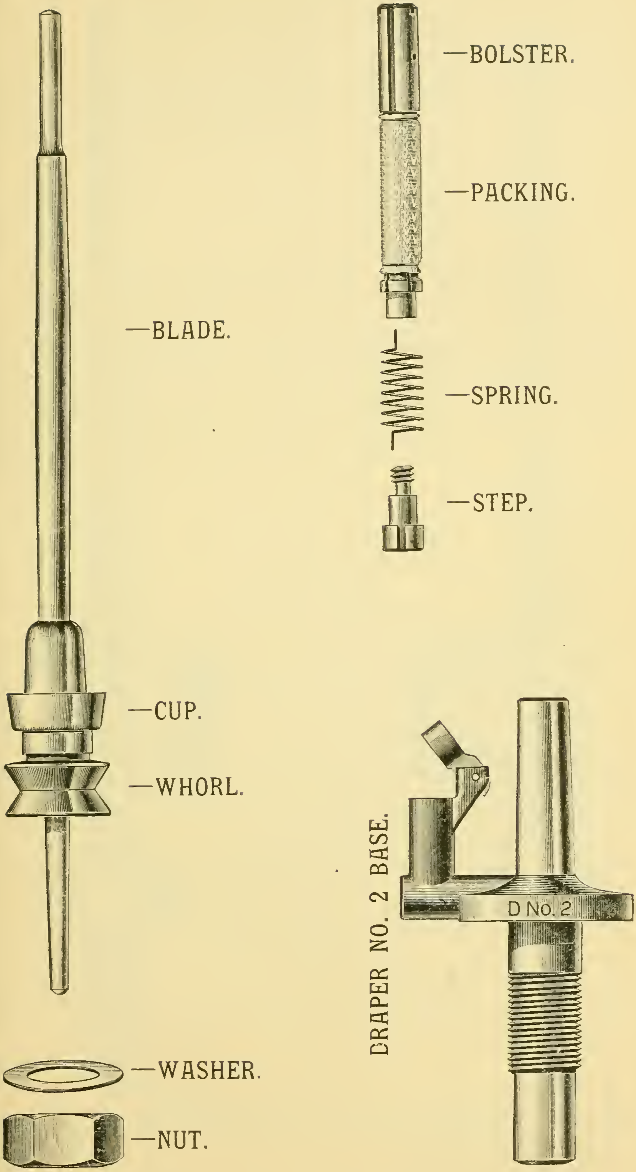
WASHER—one size for No. 1 and 2; larger for 3 and 4.

OIL CAP—for bases No. 1 and 3, one style.

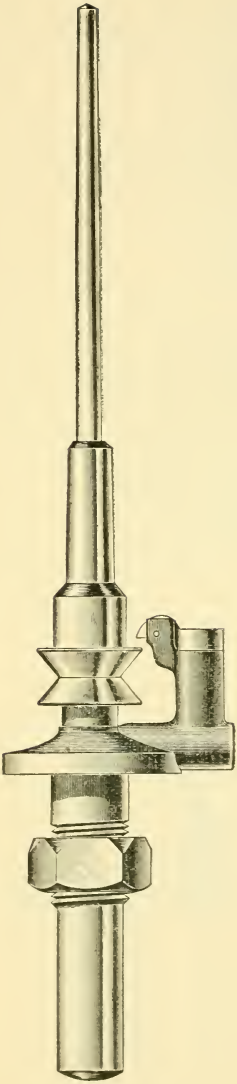
SPINDLE HOOK—for bases No. 1 and 3, sometimes made with long top to cover band.

DOFFER GUARD—specify number of base it belongs on.

When ordering parts for repairs, specify by above names and give full particulars.

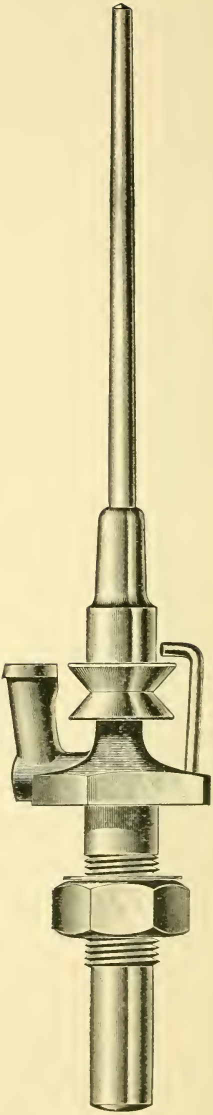


PARTS OF DRAPER SPINDLE,
Illustrated and named.



WHITIN SPINDLE.

(Is also made with bobbin cup.)



McMULLAN SPINDLE.

THE WHITIN SPINDLE.

This spindle is well known to the trade, as can be shown in our list of spindle sales. It is durable and efficient, and contains many valuable features.

THE McMULLAN SPINDLE.

This type has been manufactured in large quantities by the Saco Water Power Machine Company, and gives good satisfaction. Its distinguishing features are an extreme length between bearings and a step held loosely within the loose bolster. It drives the bobbin without a cup.

LICENSES.

The five spindles in the market at the present day are the Draper, Rabbeth 49 D, Whitin, Sherman and McMullan.

We control the sale of all these types, and have arranged for their manufacture and introduction as follows:

Geo. Draper & Sons have the entire right to supply all of these forms for old spinning frames. They also furnish Draper and 49 D spindles to any builders of new frames.

Fales, Jenks & Co. and the Lowell Machine Shop build the Draper and 49 D spindles for new frames.

The Whitin Machine Works build the Whitin, Draper and 49 D spindles for new frames.

The Saco Water Power Machine Co. build the McMullan for new frames.

All other builders obtain their spindles from Geo. Draper & Sons.

The following list shows the largest users of modern high speed spindles, not counting Sawyer or Rabbeth Sawyer:

B. B. & R. Knight	234,265
Fall River Iron Works	178,462
Lonsdale Co	157,593
Pacific	137,936
Clark Thread	123,937
Amoskeag	121,134
Wamsutta	118,047
Durfee	106,463
Merrimack	102,854
Pepperell	94,784
Willimantic Linen	88,576
Bennett	87,832
Great Falls	77,100
Sagamore	75,744
City	75,030
Hamilton Woolen	72,248
Acushnet	71,993
Lawrence	69,137
Social	69,049
Dwight	68,064
Tremont & Suffolk	65,972
Globe Yarn	63,865
Seaconnet	62,857
Stafford	61,440
Osborne	60,384
Pocassett	60,321
U. S. Cotton	60,162
Border City	59,820
Hargreaves	59,128
Merchants	57,280
Massachusetts	54,931
Harmony	54,001
King Phillip	53,700
Ponemah	54,304
Granite	52,980
Pacolet	52,924
Grosvenor Dale	52,784
Bates	52,120
Amory	51,761
Chace	51,290
Arlington	50,526
Howland	50,490
Bristol	50,176
Edwards	49,954
F. R. Manufactory	49,266
Potomska	49,068

THE MANUFACTURE OF SPINDLES.

There is much in the spindle art that the uninitiated never realize. The workmanship and processes necessary in order to produce millions of structures that will run for years at a speed of thousands of revolutions per minute, is not a matter of ordinary machine practice.

In order to have castings that can be rapidly tooled, a high grade of iron is necessary at the start. The annealing process they are submitted to is different from any other method, as it was developed in our own works and patented.

The lathes, drills and chucking machines used on this work are of special design, and in many cases involve high inventive skill. They enable cuts to be taken at a rapidity that is surprising, and reduce the labor necessary to the lowest possible point. When the parts are finished they pass from the contractor to an inspector. Every important cut is guaged and every imperfect piece sent back. On several parts the guage limit is within one thousandth of an inch.

A spindle blade is not so simple as it looks. There are many ways in which it may be imperfect, yet appear all right. The question of stock and temper are only settled by long experience. The straightening is a most tedious, careful process.

In assembling, the greatest care is used. Special tools are necessary to true the whorl so as to be absolutely concentric. The spindle must be re-straightened after the whorl is on, to cure any chance bend. As parts are all guaged they are interchangeable. Assembling, therefore, only requires skill in adjusting the fit of the spindle in its bearing.

When the spindles are complete they are passed to a further inspector, who is not an employee of the company which made the parts. This man tests each spindle before it is sent out on a specially constructed device that runs each spindle at a speed of 12,000 turns per minute. If there is the slightest vibration or jar the spindle is sent back, and none can be sent out without having been finally pronounced perfect.

The end is not yet. It has been found that in shipping spindles there was liability for damage, owing to severe handling in transit. We have for years used a special form of spindle rack and box that protects the structures so far as human ingenuity can devise.

Were we to make spindles without paying attention to the fine points, and without the critical system of inspection, we could save large sums. Probably a great part of the spindles would run well even then. We have never been content, however, to make an inferior article to save expense, and we do not think that even a severe competition could force us to abandon our methods. We do not believe that we have controlled the spindle industry entirely by patents. We think careful, consistent improvement in mechanical processes, as demonstrated in the product, has done its share.

POWER.

A very large proportion of the whole power required for a cotton mill, is consumed in driving the spinning. A generally accepted estimate has been that as much as half of all was required by this department. Of course this estimate was in general terms and liable to considerable variation under different circumstances. It is, however, sufficiently accurate to justify the statement that the question of power required by ring spinning is one of great importance to every manufacturer, especially if steam is the motive power. In many cases where there is little or no margin of surplus power, or where it is desirable to increase the product, it is an absolute necessity to economize by using the machinery which, other things being equal, will run the lightest.

Within ten years past we have expended several thousand dollars in testing various forms of spindles for the purpose of ascertaining the power required to drive different regular and experimental types. We have endeavored to discover the natural laws affecting the running of spindles, and feel sure we have learned some things not known before to ourselves or any others we have come in contact with.

The question of determining the amount of power required to drive certain spindles is one of a very complex nature, and requiring great experience and precision. There are so many causes at work having an effect upon the power required, that no one not conversant with all the details of a spinning frame can possibly secure accurate results.

We have probably given more time to making power tests on spindles than any other concern. In one of our late tests we ran a frame every day for six months, with three men employed all that time making observations. We find some of the chief causes for variations are as follows:—

Difference in spindles.
Difference in frames.
No. of yarn spun.
Tightness of spindle bands.
Looseness of fit of spindles.
Gravity of oil used.
Size of bobbin.
Diameter of ring.
Length of traverse.

Proper lubrication.
Proper adjustment of rings and guide wires.
Weight on rolls.
Proper set of gearing.
Cleanliness of frame.
Viscosity of oil used.
Temperature.

As there are several conditions that can change a result ten to thirty per cent., it is evident that no comparisons can be made where these conditions are not more or less uniform.

The proper way to test a frame is to run it through the dynamo or power scale from the time of doffing until the bobbins are half full, or until that point is reached which experience has shown to be the average between start and finish, taking readings every fifteen minutes at least. If the readings increase gradually without any unreasonable change, it is to be expected that everything is in proper order. Take readings of the frame at this point. This will give the average power taken by the frame very closely. Take the readings at the centre of the traverse. Now break down all the ends, keeping the rolls running. The difference between these readings and the former will show what power the traveler pull takes. Then stop the frame, throw the rolls out of gear and run the spindles with the bobbins on. Take readings, and then take the bobbins off and run the spindles bare. Then piece up and take readings till doffing time, and average the whole result of the spinning readings. It is simpler, though not quite so accurate, to consider the average power the mean between the first and last readings, or the reading taken when bobbins are spun half full.

With all these data, it is easily shown where the power is used up. Thus the spindles alone take a certain proportion, the weight of the bobbins and yarn adds an increase, the traveler pull yet more, and the rolls and traverse make the whole. It would surprise many to see how this power is divided. The traveler pull is much more of a factor than is generally supposed.

From a test at 9300 revolutions with 1½ ring on No. 43° yarn the proportion was as follows:

Power taken by rolls, traverse motion and gearing,	11 per cent.
Power taken by weight of bobbins and yarn	11 per cent.
Power taken by traveler pull	17 per cent.
Power taken by cylinder and bare spindles	61 per cent.
	100

Another way is to figure for each spindle the power taken by each adjunct.

From a test at 9300 revolutions with 1¾ inch ring on No. 28° yarn the proportion was as follows to each spindle:

Horse power of rolls, traverse motion and gearing,	.0011
Horse power of weight of bobbins and yarn	.0022
Horse power of traveler pull	.0031
Horse power of bare spindle	.0069
Horse power per spindle spinning	.0133

Many false ideas are afloat about the power that might be saved by taking weight off the rolls. As is seen, the whole power consumed by the rolls in good condition is small, and a large per cent. difference in their power would mean little in the general result.

It may also be inferred that a spindle which may run very much lighter than another bare, will by no means affect the general per cent. of the frame by an equal amount.

We are often asked about the number of spindles to a horse power on various numbers of yarn under different conditions. This may vary so under the conditions that it is a difficult question to answer. The only way to get a definite answer to such a question, is to send a statement asking what should be expected under stated conditions.

The real question in power is to know what can be done to lessen the amount required. In the first place, choose the lightest running spindle. The Draper has been shown to be that one in competitive tests. The next best way to save power is to watch the banding. We have made tests showing that it is perfectly easy to waste ten to forty per cent. of power by having bands too tight or by having uneven banding. If the spindle will not run without making slack yarn with a loose band *see what is the matter with the spindle*, instead of simply putting on a new band with a high tension.

As between two different sizes of spindle, the smaller will usually take the least power. It may happen, however, that the smaller spindle, if put to too great a strain, will wear out rapidly and cause poor spinning by excessive vibration. We have found that our two standard sizes of spindle vary about 20 per cent. in power. Our latest Draper Spindle is the lightest in running of any we ever tested, and is suitable for any work up to and including a two-inch ring. The use of the larger size on this work will therefore simply waste the 20 per cent. above noted.

We recommend a two pound band pull, and make all our tests on this basis. A new band should not pull above three pounds, nor an old band less than one pound. A band tension scale will show just what you have. Two pounds will run any modern spindle that is not stuck in its bearing. A band that is put on too tight loses all its pliability and becomes wiry. The best way we know to have bands put on at a proper tension and have uniformity of tension, is to use a Weeks Banding Machine with a Marker attachment.

Light oil will make a material saving in power, and we fully recommend its use. An oil of from 33 to 38 gravity with little viscosity, is about right. The price is not to be considered in spindle oil. Get the best.

It helps in power to have the spindles central with the ring and free in their bearings.

We are informed by Mr. F. P. Sheldon, certainly a most competent authority on questions of engineering, that the result of his experience is that in comparing the power required by Sawyer warp and mule filling with a mill running modern Rabbeth at high speed for both warp and filling, he finds that the product per horse-power is the same. That is, the increased product from the high speed balances the increased power. The result is also about the same comparing with the Rabbeth warp and the best high speed mule filling.

THE PATENT SITUATION.

We, as the agents of the Sawyer Spindle Co., have introduced or obtained the control of every spindle of prominence during the last twenty-four years. In that time we have been constantly experimenting, and have acquired control of nearly four hundred patents on spindles, two-thirds of which are still unexpired. We believe that it is impossible to construct a spindle that will run practically at modern high speed without infringing some of our active patents. No one has ever successfully defended a suit brought by us for infringement, and we believe that our position is so strong by patents, experience and reputation, as to deter sensible men from attempting to compete in this line.

We own or control the patents on the following spindles, which are the only ones sold to any extent in late years to our knowledge:

Atwood. (Silk spindle.)
Whitin.
49D Rabbeth.
Sherman.
McMullan.
Draper.

In the development of the spindle business, it has been necessary to be involved in all sorts of litigation to defend ourselves against infringement. No patent of great value can be maintained at the present day without having had its claims fully defined by a judge. With the enormous amount of work that falls upon our patent office officials and the numberless inventions in all stages of progress, it is impossible for a patent to be sure of protecting its owner.

Our legal history has been lengthy and progressive. We have seldom known a period when we had not several important patent suits being carried on simultaneously. We, however, stand firmer than ever at the present time, the inevitable result of our success in establishing our rights before the courts.

The following inventors have materially aided the advance in spindle construction:

Allen, G. H.
Atwood, J. E.
Birkenhead, J.
Buttrick, C. G.
Carroll, W. T.
Chapman, C. H.
Day, F. M.
Draper, G.
Draper, Wm. F.
Draper, G. A.
Draper, G. O.
Fay, R. C.
Flanders, T. B.
Gray, J. R.
Hinchliffe, W.
Jenks, B. H.
Jaquith, G.
Kilburn, J.
Knight, G. W.
Mayor, T.
McDuffie, C. D.
McMullan, J. H.
Northrop, J. H.
Pearl, Oliver.
Rabbeth, F. J.
Raworth, J. S.
Richardson, G.
Sawyer, J. H.
Sherman, A. R.
Taft, G. E.
Tynan, J. E.
White, R.
Wood, A.
Woodmancy, H. D.

We are inclined to think we completely cover the ground on sleeve whorl spindles, having Loose Bearings, Yielding Bearings, Elastic Bearings, Rocking Bearings, combinations of the above with rigid upper or lower bearings, Ball and Roller Bearings, and every possible combination by which any part of the spindle has capability for lateral or vertical movement while running, with relations to the rail or other stationary parts of the frame.

We have had the field gone over by legal and mechanical experts, patents of every age examined, law suits and interference cases won, and with the light of our years of research and experience, stand behind our patents confident against infringement of others, and guaranteeing our customers against others' claims.

TABLE OF COMPARATIVE SPEEDS AND PRODUCTION OF WARP YARN OF SAWYER AND RABBETH SPINDLES.

No. of yarn.	Size of spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Revolutions Front Roll.		Revolutions Spindles per Minute.		Hanks per Spindle per Day of 10 hr.		Pounds per spindle per wk. of 60 hr.	
					Sawyer.	Rabbeth.	Sawyer.	Rabbeth.	Sawyer.	Rabbeth.	Sawyer.	Rabbeth.
5	Draper No. 3 or 4.	3 inches.	2¼	7 or more.	132	158	4400	5400	7.23	8.70	8.675	10.44
6					131	156	4800	5800	7.17	8.60	7.175	8.60
7					130	154	5100	6100	7.12	8.50	6.102	7.28
8					129	152	5400	6400	7.06	8.40	5.298	6.30
9					128	151	5700	6700	7.01	8.30	4.673	5.53
10			2⅛		127	150	6000	7000	6.95	8.20	4.173	4.92
11					126	149	6200	7200	6.90	8.10	3.764	4.41
12					124	148	6400	7500	6.79	8.00	3.395	4.
13					122	146	6600	7700	6.68	7.90	3.084	3.64
14					120	144	6700	7900	6.57	7.80	2.816	3.34
15					117	142	6800	8100	6.41	7.70	2.563	3.08
16		2¾ inches.	2		114	140	6800	8300	6.31	7.60	2.367	2.85
17					112	138	6900	8500	6.20	7.50	2.188	2.64
18					110	136	7000	8600	6.09	7.40	2.030	2.46
19					108	134	7000	8700	5.98	7.30	1.888	2.31
20					105	132	7000	8800	5.80	7.22	1.741	2.16
21	Draper No. 1 or 2.				102	130	7000	8900	5.72	7.14	1.634	2.04
22					101	128	7100	9000	5.67	7.06	1.547	1.92
23					99	126	7100	9100	5.55	6.98	1.447	1.82
24					99	124	7200	9100	5.52	6.90	1.379	1.72
25					96	122	7200	9200	5.40	6.82	1.296	1.63
26					96	120	7300	9200	5.42	6.74	1.251	1.55
27			1¾	6 to 6½	94	119	7300	9300	5.32	6.66	1.183	1.48
28					94	118	7400	9300	5.30	6.60	1.147	1.41
29					92	117	7400	9400	5.20	6.55	1.077	1.35
30					92	116	7500	9500	5.19	6.50	1.037	1.30
31					90	115	7500	9500	5.16	6.46	.998	1.25
32					89	115	7500	9500	5.08	6.43	.953	1.20
33			1⅝	5½ to 6	87	114	7500	9500	5.00	6.40	.910	1.16
34					86	114	7500	9600	4.93	6.36	.869	1.12
35					85	113	7500	9600	4.85	6.32	.832	1.08
36					84	112	7500	9600	4.78	6.28	.797	1.04
37					83	111	7500	9700	4.72	6.24	.766	1.01
38					82	110	7500	9700	4.66	6.20	.736	.97
39					80	109	7500	9700	4.60	6.15	.707	.94
40			1½	5 to 5½	79	108	7500	9700	4.55	6.10	.682	.91
41					79	106	7500	9700	4.54	6.00	.664	.87
42					78	105	7500	9700	4.48	5.92	.640	.84
43					77	104	7500	9700	4.42	5.85	.617	.81
44					76	103	7500	9700	4.37	5.79	.596	.79
45					75	102	7500	9700	4.32	5.70	.576	.76
46					74	100	7500	9700	4.27	5.65	.558	.73
47					73	99	7500	9700	4.23	5.60	.540	.71
48					73	97	7500	9600	4.18	5.55	.523	.69
49					72	96	7500	9600	4.14	5.52	.507	.67
50			1⅜	4½ to 5	71	95	7500	9500	4.10	5.50	.492	.66
55					68	91	7500	9500	3.92	5.25	.427	.57
60					65	88	7500	9500	3.75	5.00	.375	.50
65					62	85	7500	9500	3.60	4.80	.332	.44
70					60	83	7500	9500	3.47	4.60	.298	.39
75					58	80	7500	9500	3.36	4.47	.268	.35
80					56	76	7500	9500	3.25	4.35	.243	.32

PRODUCTION TABLES.

On the preceding page we give a table which is prepared from the following data: The Sawyer columns are taken direct from our 1887 edition, as we see no need for changing. The Rabbeth are taken from present actual results in some of our best mills, supplemented by proportional estimates on numbers that we had no statistics from. The spindle speed is the actual and not the figured speed. Where spindles are claimed to run very high, as on English frames for instance, the figured speed is usually the data, which may be ten per cent. or more above the actual conditions. These results are by no means maxima, although they may be above the average. Proper allowance has been made for doffing, waste, etc.

FILLING FRAMES.

The table of speed and production on filling frames, found on the opposite page, is partly prepared from actual results and partly by computation. We find that mills vary so much in the speeds of filling frames that it is hard to average results in such manner as to get a uniform table. We know that the speeds we give are not high, and we prefer to have them a medium rather than a maximum.

There has been considerable advance in speeds on filling since our last table was published, the gain averaging more than on warp. While our table only gives figures up to No. 50 yarn, it is of course understood that filling frames are successfully used on much higher numbers. Such use, however, is not general enough from which to deduct reliable statistics at present. We do not give the speeds of the spindles, as there is such variation in amount of twist put in on the same numbers. This is a matter to be determined largely by the goods woven.

SPINNING FILLING ON RING FRAMES.

The greatly increased use of frame filling in the past few years, undoubtedly received its first impulse from the introduction of the evener by the late George Draper. While many frames are now built for filling without the evener attachment, it is doubtful if manufacturers would ever have appreciated the gain in spinning filling on ring frames if it had not been for the persistent efforts made during the introduction of the evener. We have faith in this device, and recommend it wherever

TABLE SHOWING THE PRODUCTION OF DRAPER'S FILLING SPINNER FOR DIFFERENT NUMBERS OF YARN, UNDER THE TEN-HOUR SYSTEM.

No. of yarn.	Size of spindle.	Gauge of frame.	Diameter of rings.	Length of traverse.	Revolutions of Front Roll.	Hanks per day of 10 hours.	Pounds per week of 60 hours.
6	Draper No. 1 or 2 for all numbers.	Never have a frame less than 2¾ gauge.	1½ to 1⅝	5 to 7 inches, according to length of bobbin used.	178	8.95	8.95
7					176	8.90	7.62
8					174	8.85	6.64
9					172	8.80	5.86
10					170	8.75	5.25
11					168	8.70	4.74
12					166	8.63	4.31
13					164	8.56	3.95
14					162	8.48	3.62
15					160	8.40	3.36
16			1½		158	8.32	3.12
17					156	8.24	2.90
18					154	8.16	2.72
19					152	8.08	2.55
20					150	8.00	2.40
21					148	7.92	2.26
22					146	7.84	2.13
23					144	7.76	2.02
24					142	7.68	1.91
25					140	7.60	1.82
26			1⅜		138	7.52	1.73
27					136	7.44	1.65
28					134	7.36	1.57
29					132	7.28	1.50
30					130	7.20	1.44
31					128	7.10	1.37
32					126	7.00	1.31
33					124	6.90	1.25
34					122	6.80	1.20
35					120	6.70	1.14
36					118	6.60	1.10
37			1¼		116	6.50	1.05
38					114	6.40	1.01
39					112	6.30	.97
40					110	6.20	.93
41					108	6.10	.89
42					106	6.00	.85
43					104	5.90	.82
44					102	9.80	.79
45					100	5.70	.76
46					98	5.60	.73
47					96	5.50	.70
48					94	5.40	.67
49					92	5.30	.65
50					90	5.20	.62

Any one in doubt between the Mule and the Frame can find food for thought in comparing the above production with that of the best mules.

our recommendation is appreciated. Comparative tests have proved that yarn could be spun with less twist and less breakages, when this invention is used. Manufacturers have, however, found that filling can be spun on frames without the evener, and many do not care to pay the additional cost. In one way, this makes no difference to us, as we have never taken royalty for the evener, and have no chance for profit in its introduction, except as it may cause more filling spindles to be used. We do not mean to say that filling was never spun on ring frames before the introduction of the evener. Certain hard-twisted coarse filling had been successfully made, but no one attempted to spin slack-twisted filling of the finer numbers. We think that experience has now proved that filling as fine as 50s, and all numbers up to 50s, can be spun on frames to better advantage than on mules, all things considered. With the evener, filling yarn can be spun as slack as it need be for any purpose; it can also be wound harder on the bobbin, as a heavier traveler can be used with the evener than without it. The advantages of bobbin filling are less waste in weaving, less breakage of the filling in weaving out of the shuttle, less cost per pound for labor, less floor space necessary for machinery. There is also one less department in the mill, one less overseer, and a class of help is dispensed with that mill management has always found troublesome.

Experience has shown that filling yarn can be spun on bobbins to much greater advantage than in former years. A mistake is sometimes made in trying to get too much yarn on the bobbin, by lengthening the traverse injudiciously. Unless the shuttle is properly proportioned and has a proper friction, it is often probable that a long traverse bobbin will break the filling while weaving off. No doubt the improvements in spindles and separators have permitted better results with the filling frame than formerly.

That the mule is going out of fashion, can be easily proved by noting the equipment of modern new mills.

Frame filling yarn, to weave to the best advantage, should be allowed to age before going into the looms. It is also well sometimes to sprinkle or steam the yarn. It is found in many cases that the damage to the bobbins from the moisture, is more annoying than the lack of moisture in the yarn. Some mills let their filling age for days, and even weeks, before using. A new advantage of frame filling is introduced with the use of the Northrop loom: while cops can be used with this loom, their use involves the operation of skewering the cops before placing in the loom hoppers. While this is not a serious disadvantage, it does take extra time and adds an additional expense for skewers.

THE RHOADES CHANDLER SEPARATOR.

As we have applied about 7,000,000 separators of various kinds in the last two decades, we can easily assume authority on the subject. In giving advice, we always try to consider our customers' interests above our own, believing that that system evolves the best results to those intending to continue business. Bearing this principle strictly in mind, we have no hesitation in recommending the Rhoades Chandler Separator above every other known type.

Separators are simply intended to separate. They are more or less of a nuisance, but they are a necessary evil, and we have tried to eliminate their defects so far as possible.

With the large ring and long traverse so common at the present time, the old Doyle device was found inefficient. A wider blade was absolutely necessary, but the Doyle idea would not allow a wide blade.

Mr. A. D. Chandler deserves the credit for devising operative wide-bladed separators, and we have adopted his main ideas in the form we sell to the trade under the name of the "Rhoades Chandler," shown below.

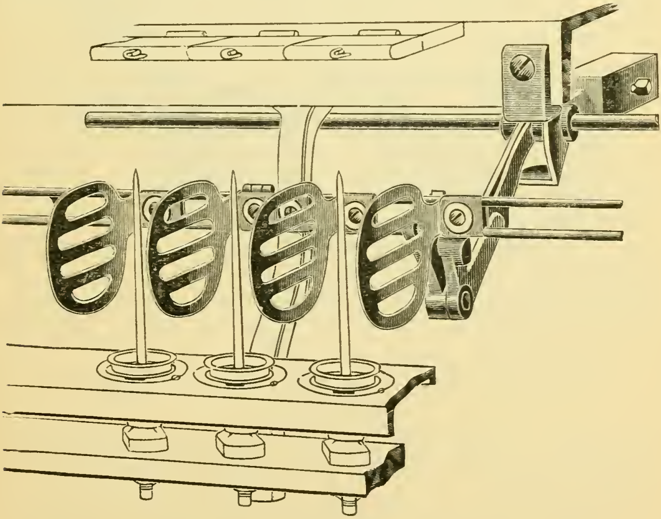


FIGURE I.

The Lowell Machine Shop use a type of Chandler Separator under license from us. While very efficient, it is not easily adaptable to other makes of frames.

The wide blade brought with it a hindrance to the act of doffing. The Rhoades modification of the Chandler idea solved this problem by a mechanism which allows the blades to be turned down behind the ring rail. On some makes of frame they can also be turned up back of the ring rail, but the down turn is most convenient.

Figure I shows a few blades in the position they occupy when the rail is at the lower part of the traverse. It will be noticed the stamped steel plate is used, and the double rod frame of the Doyle adapted to it. Cast iron blades are too heavy when made wide, and do not present so smooth a surface as those of steel. The rods and clamps shown cannot be improved upon for adjustment and stiffness. The frame of separators is supported by swinging arms, the pivot being situated far back under the roller beam, so that the motion is very easy. Unlike the Doyle, the blades are not tipped at such an angle that ends are liable to catch on them when the traverse is high.

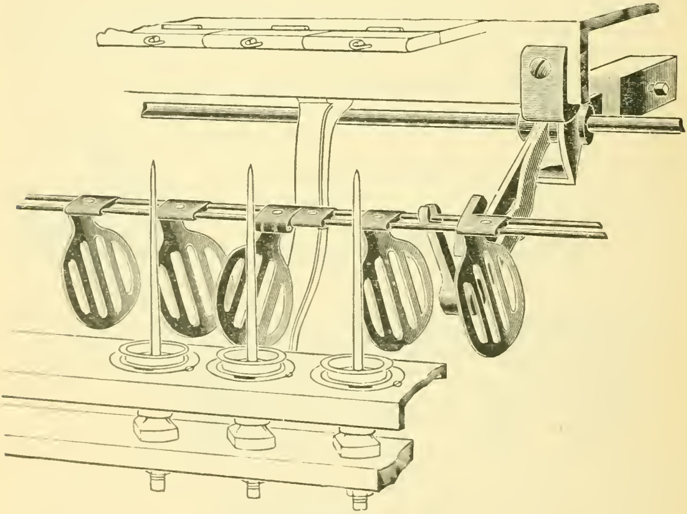


FIGURE II.

Figure II shows the separators turned down for doffing. Unlike the Doyle, the separators will stay in place, and do not need to be propped up by a bobbin or lifting device.

Figure III shows the separators in an upturned position.

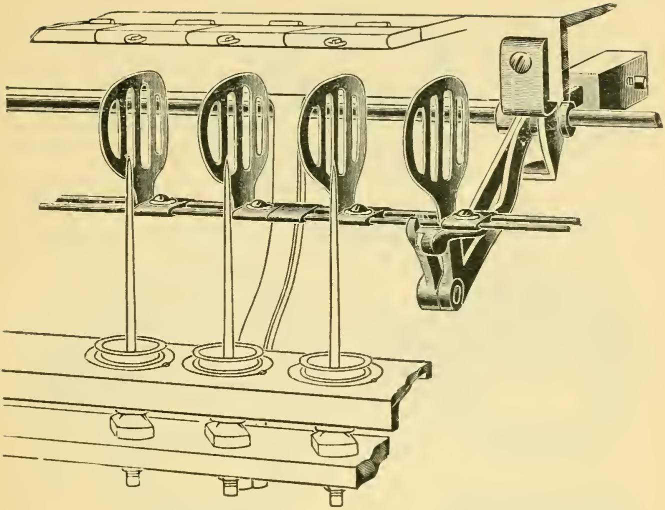


FIGURE III.

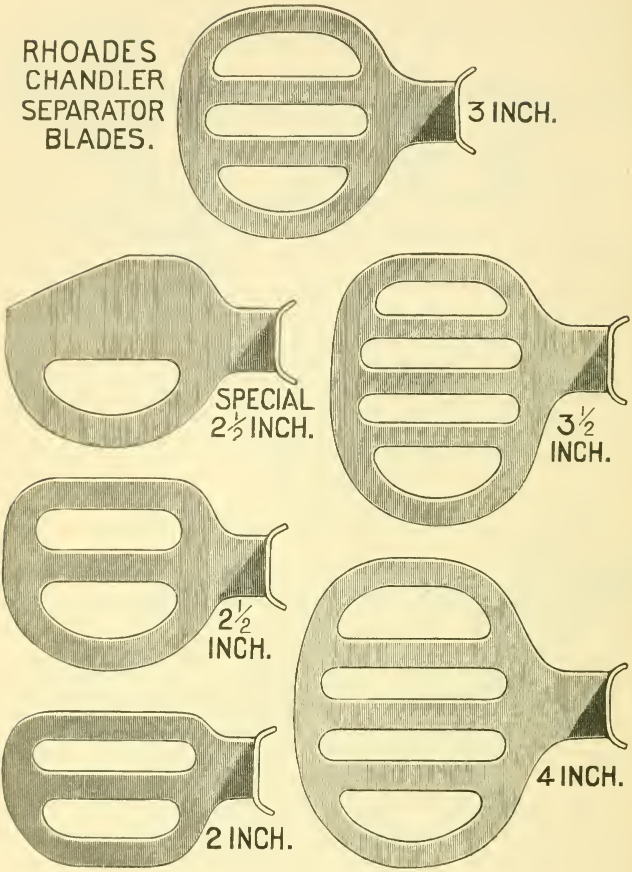
The question of proper size of blade is very important. We show a group of popular blades. We make many others, but these fill the usual needs. With a long traverse a wide blade is an absolute necessity. The use of larger rings also demands a wide blade, as the guage of the frame is not always increased in comparison with the diameter of the rings.

Our blades are of stamped metal and have a smooth finish. They will not break, and if bent by accident can be re-bent to shape.

We control all the patents on Separators that we consider of any value, but independent of patents, we believe our separators can compete on merit alone. At the price we sell separators there is no inducement for competition, except by palming off a cheaper (to the maker) separator under the guise of equal efficiency.

SPECIFICATIONS FOR RHOADES-CHANDLER SEPARATORS.

Builder of frames?
Number of frames?
Number of spindles in each frame?
Gauge of frame?
Total length between end spindles?
Length of traverse on bobbin?
Width of ring rail?



These blades are shown reduced in size, and do not measure the width claimed in the drawing.

Distance top of roller beam to top of bolster rail, C to D?

Distance top of ring rail when at its highest point of traverse, to top of roller beam?

Distance face of roller beam to center of spindle, A to B?

Distance under side of guide board to bottom of roller beam?

Width of face of roller beam, G to H?

Is there a place to run a rod the length of frame, 8 inches back of spindle and 3½ inches from top of roller beam?

If not, state what is the nearest position such a rod may be placed in?

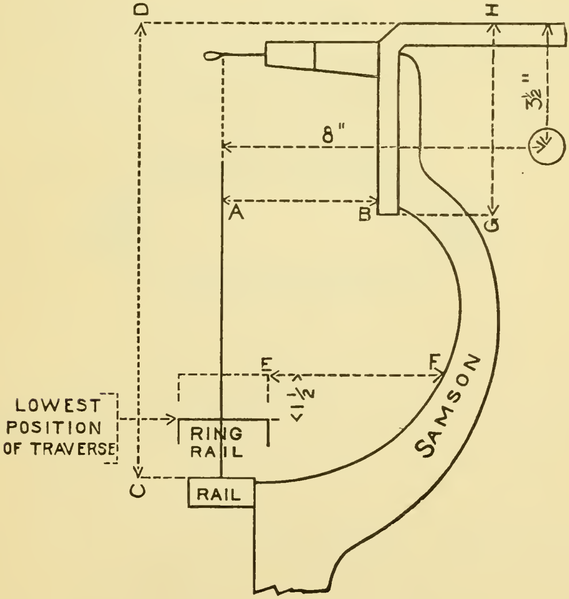
Distance between back of ring rail and samson in horizontal plane when traverse is 1½ inches from bottom, E to F?

Number of samsons to a frame?

State between which spindles the samsons come?

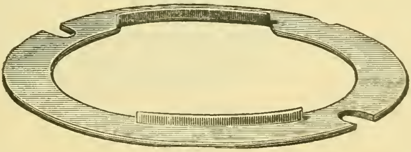
Ship via?

Blank specification sent on application.



DOUBLE ADJUSTABLE SPINNING RINGS.

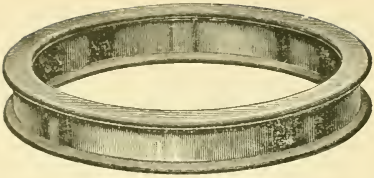
We have continuously manufactured double flanged spinning rings since the year 1869. During the greater portion of that time, we have practically controlled the ring business of this country, as the double ring has gone into almost universal use. Since 1885 we have had competition, as our main patent on the double ring then expired. Our sales, however, have increased in volume since that time, and, while we do not pretend that our competitors do not receive a fair proportion of orders, we think we still supply at least three-fourths of the rings annually used. While the single ring has gone out of use on account of its greater expense and greater wear, there are still a few manufacturers who claim that it gives better results than the double ring, and who still prefer it on their frames. The obstinacy of certain types of human nature is proof against conviction, and we have no desire to argue where argument is useless. We claim that the double ring is cheaper and will wear longer. The only claim against the double ring is the fact that for the first few days or weeks of use, the single ring seems to start up better. We have always explained this fact by showing that our ring, being of a harder steel, cannot help wearing the travelers more during the short time it takes for the traveler to wear itself a smooth surface. The fact that our rings wear longer, proves that they are harder. While certain methods may tend to improve the ease of starting up, there is nothing, in our opinion, to equal the result obtained by the use of the traveler itself. This matter at the best is trivial, and the fact that we have sold over 9,000,000 rings, proves that our customers consider it in that light. The manufacture of a standard article for so many years, naturally brings to light facts that can only be learned by time and experience. We have found that the greatest difficulty in the manufacture of perfect rings, was the necessity for keeping the stock of certain uniform high grades. There have been periods when, without our knowledge, changes in stock were made that seriously affected the quality of large ring products. As these defects could only be proved by use, we have at times found our rings unsatisfactory. At all such times we have been willing to replace such rings, and used greater efforts in producing a superior product. We finally decided that the best way to cure the evil was to get at the root of the matter, and forge out rings in a plant of our own from stock that we personally selected. We have found this change eminently satisfactory to us and our customers alike. We now buy stock in large quantities from one concern, and haye the surest possible guarantee of its uniformity and high grade. This stock is forged by ourselves, in a drop forging plant of nine-power hammers. Unlike some other manufacturers, we forge our rings from the solid bar without a weld. While rings made with a weld can be perfect if the weld is perfect, there are too many chances for error, and we prefer the surer method. So far as we are aware, we are the only manufacturers making their own drop forged rings. Our plant for manufacturing rings from the forgings, is the largest and most complete in this country. We have a system of inspection that is so thorough, that no possible defect in tool work or finish can possibly pass undetected. The defects in stock that we referred to could not be found by inspectors, as they were a part of the chemical constituents of the steel itself. That our inspection is thorough, can be shown by the fact that out of a lot of finished rings made by another manufacturer and given to our inspectors without their knowledge of who the manufacturers were, 90 per cent. were thrown out as defective on account of errors in roundness, poor polishing, and tool marks. There are, of course, many parts of the ring where tool marks and poor finish have no effect on the running of the traveler. We prefer, however, to have the ring perfect at all points, and keep our product up to the highest possible grade.



SHEET METAL HOLDER.

Rings are kept in place upon the ring rails by several mechanical contrivances, the best of which, in our opinion, is the sheet metal plate holder. Many manufacturers prefer the cast-iron holder with three screws in the rail for adjustment. We can furnish either kind desired.

Where traveler cleaners are desired, we can furnish plate holders having a turned up edge that serves the purpose better than any device we know of. With this cleaner there can be no change of position, and it cannot be easily broken. With cleaners made adjustable, there is too great liability for change in adjustment, making a large part of them useless for the purpose. They are also very likely to get loose and be lost. With the cast-iron holder, we can also furnish a very efficient cleaner, when desired, but think the plate holder superior.

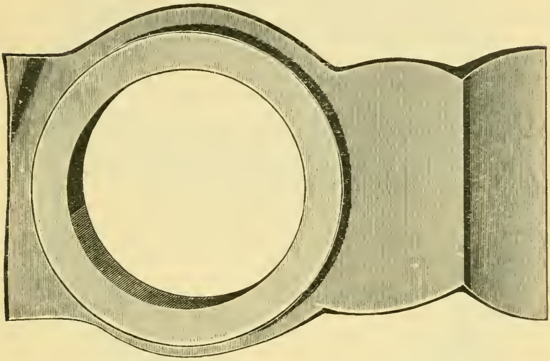


YEAR.	NUMBER RINGS SOLD.	NUMBER RINGS SOLD FOR REPLACEMENT OF DOUBLE RINGS.
1869	6,025	
1870	20,258	
1871	38,648	
1872	94,264	12
1873	117,301	
1874	168,382	500
1875	223,924	963
1876	185,319	947
1877	270,811	946
1878	215,214	3,309
1879	336,918	8,007
1880	567,860	11,264
1881	659,730	8,974
1882	636,715	22,515
1883	421,609	20,802
1884	315,565	25,105
1885	326,454	30,911
*1886	*253,004	*32,427
1887	507,185	35,176
1888	474,002	41,744
1889	767,246	38,786
1890	410,451	37,048
1891	378,494	38,399
1892	517,934	47,269
1893	512,911	81,470
1894	487,880	167,579
	8,914,104	654,153

* Signifies the period competition on double rings started, our patent having expired. It will be noticed that this competition has not apparently influenced the volume of our sales.

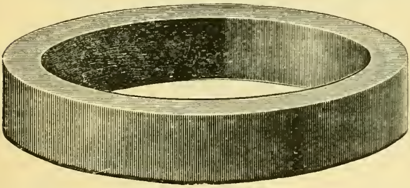
Taking the number of rings sold for repairs, it can be figured that we sold more rings than this previous to 1876. On this showing, therefore, our rings would have averaged to run over 19 years. This is not an absolutely accurate basis for figuring, however, as speeds have increased, and some of our rings may have been replaced by other makes. We cannot guarantee any definite life for rings, as conditions vary.

PROCESS OF MANUFACTURE.



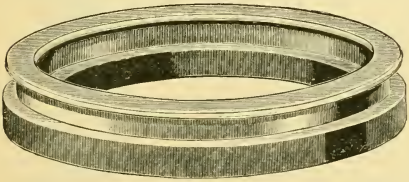
Ring blank welded from bar steel under drop hammer with centre punched out.

The blank is next punched out while hot, and is trimmed when cold in another punch, presenting an appearance as below.

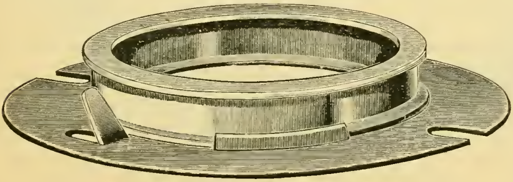


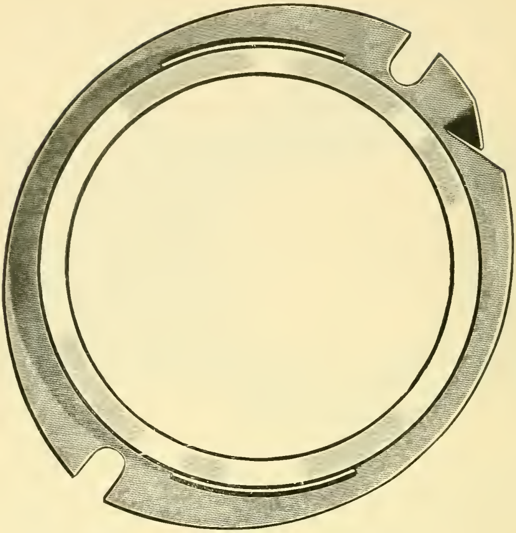
The cut shows a larger size ring than that in the first sketch.

In our lathes the forging is cut by two tools at one time. The tools cut half the forging at a time. Cut below shows the appearance after the first operation.

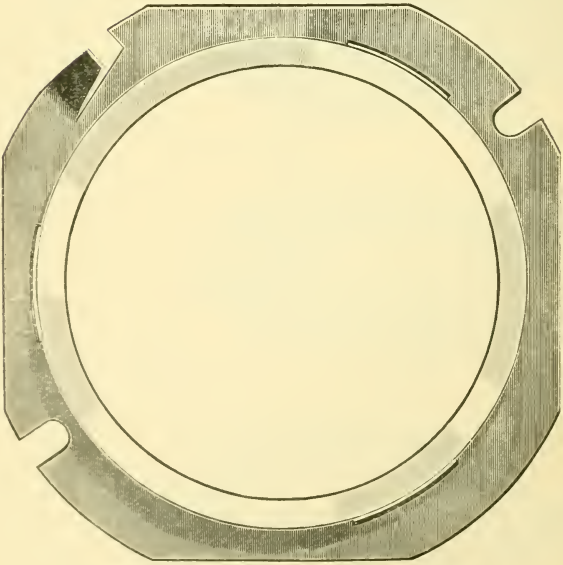


The next illustration shows a ring complete, fitted in a plate holder of latest pattern with up-turned traveler cleaner. These holders cannot be made by outside parties without infringing our patents, whether made with traveler cleaner or not. The following cuts show top views of differently shaped holders for large rings.

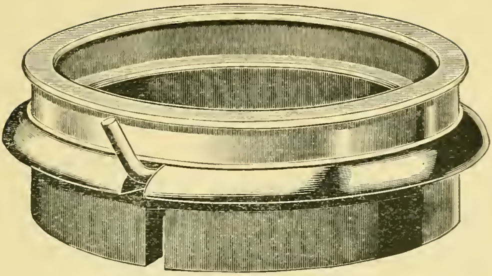




OVAL HOLDER FOR 2 INCH RING.

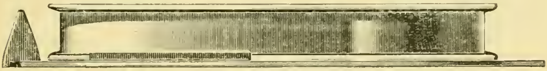


SQUARE HOLDER FOR 2 1-4 INCH RING.



Cast-Iron Holder with Wire Traveler Cleaner.

Inferior in convenience to plate-holder, but desired by some mills.



Side View of 2 Inch Ring.

We think our cuts will show that we are prepared to furnish anything desired. We assume an authority on the ring question as we have led from the start. When others follow after we have developed the bottom principles, they simply bear testimony to the fact that we were right when we championed the double ring, and right when we stood by the plate holder. We know we are also right in making drop forged blanks without a weld, in having our stock specially made for us, and in following our present methods of finishing, which are different than on any other make used.

The only competition that troubles us is that of makers who produce a ring that *looks* like ours. The difference is not perceptible to the eye, and a sufficient amount of advertising and persuasion will sell a certain amount of almost anything. The periodical attempts to make rings of glass, porcelain, rubber, stampings, etc., do not affect us. They have always been failures and probably always will be. No material of equal cost has the wear of hardened steel.

During the last few years we have given careful attention to different methods of manufacture with the intent of producing a ring that would start up better and use less travelers. We have tried different steels and irons, different tools, and different methods of polishing and smoothing. Careful tests with months of oversight and record have guided us to a correct knowledge. While we do not care to give the results of our experience for the benefit of our competitors, we can state that the ring we are at present selling is far superior to any ring we have ever made before. We have had to increase our cost of manufacture to produce this result, but have added no increased charge to our customers. This process does not interfere with burnishing, and we still ask an extra price for that finish.

We have a new patented novelty that may prove of great importance, which we shall name as follows:

THE DRAPER BEVEL FLANGE RING.

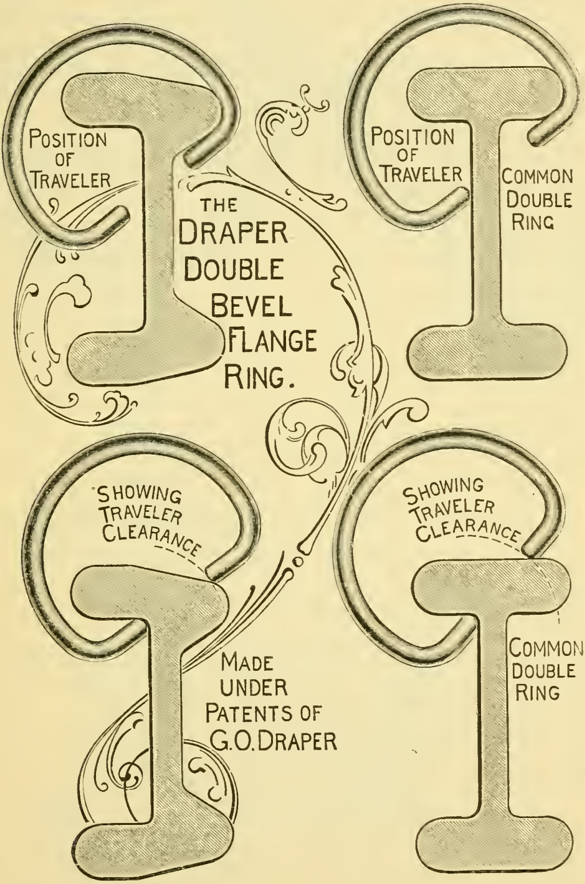
The cut is almost self-explanatory. The new shape enables a traveler to be applied without springing or breaking. It also allows the traveler to run with less chance of bearing on the outer side of the web, enabling it to have greater freedom of movement. The most important gain is the possibility of using harder travelers, which will wear longer, also the extra convenience for the spinners when putting on travelers, and the saving in number of travelers broken. We cannot as yet refer to results from extensive use, as we are just starting on its introduction. Trial of a sample frame will show whether it is an improvement or not. We charge two cents extra for this shape.

In ordering travelers for trial with this ring, explain that they are to be extra hard and need have no appreciable spring. The ordinary traveler can of course be used if desired. Where light weights are in use, the extra hardness makes a great difference in the wear so far as present tests show.

The traveler bill is of sufficient importance to consider a chance of economy. In a fifty thousand spindle mill, on yarns from 28 to 36s, the books show the following results, starting with new rings.

First year.	Cost	per	1000	spindles,	$ 17.13
Second year.	"	"	"	"	15.20
Third year,	"	"	"	"	9.71
Fourth year,	"	"	"	"	8.38

If the cost per ring averages a cent a year, it is evident that there is quite a basis to save on if a ring wears on an average 15 years or more.


POSITION OF TRAVELER
THE DRAPER DOUBLE BEVEL FLANGE RING.
POSITION OF TRAVELER
COMMON DOUBLE RING
SHOWING TRAVELER CLEARANCE
SHOWING TRAVELER CLEARANCE
MADE UNDER PATENTS OF G.O. DRAPER
COMMON DOUBLE RING

ENLARGED SECTIONAL VIEW.

The new ring allows the traveler to assume its natural position and yet have more wearing surface. The traveler is not so liable to strike the outer flange. These rings fit our regular holders.

PRICES OF DOUBLE-ADJUSTABLE RINGS.

With either cast-iron or patent plate-holder and screws.

DIAMETER IN INCHES.	PRICE	
	With either Holder.	Without Holder.
1 1-8	14 cents.	10 cents.
1 1-4	14 "	10 "
1 3-8	14 "	10 "
1 1-2	14 "	10 "
1 9-16	14 "	10 "
1 5-8	14 "	10 "
1 11-16	15 "	11 "
1 3-4	16 "	12 "
1 13-16	17 "	13 "
1 7-8	18 "	14 "
1 15-16	19 "	15 "
2	20 "	16 "
2 1-8	22 "	18 "
2 1-4	24 "	20 "

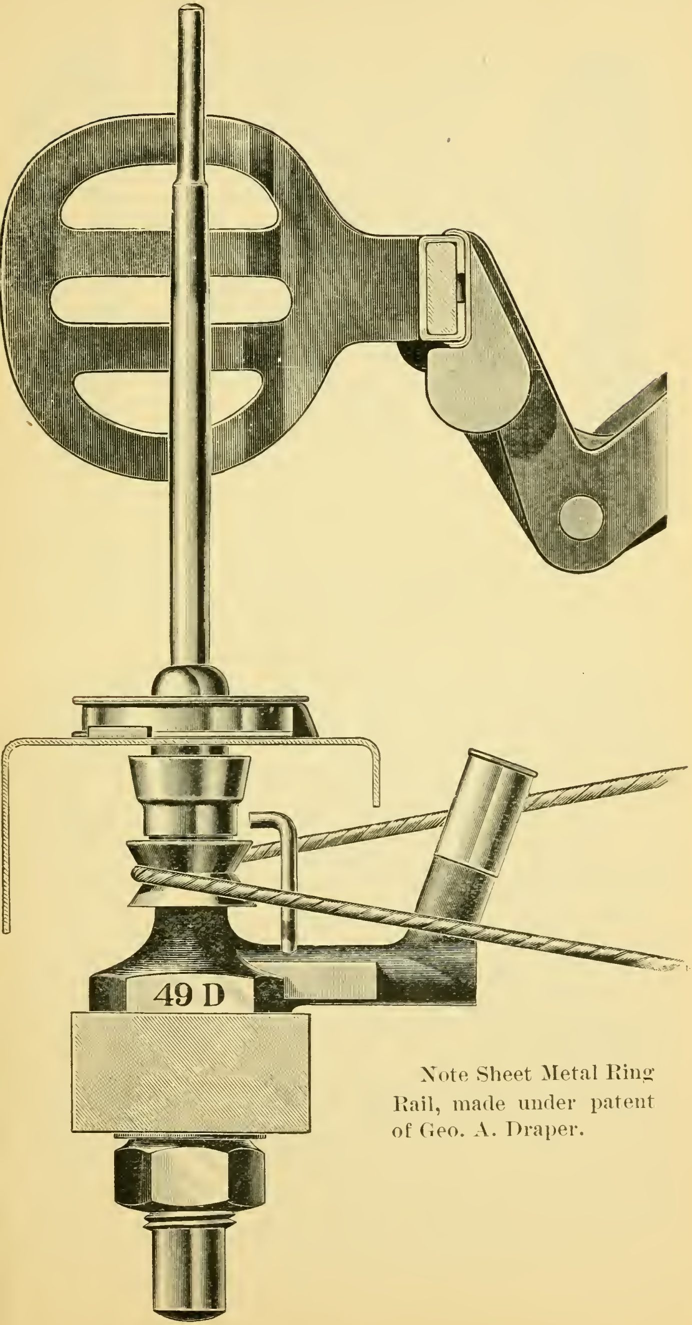
In lots of 5000 a discount of 10 per cent. will be allowed from the above price.

For bevel-flanged or burnished rings add two cents per ring to the above price.

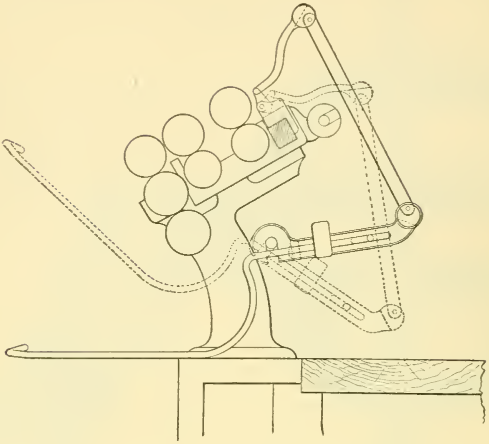
Traveler cleaners free when ordered of the type shown with plate-holders. This is the best one known, presenting no complication of parts and is always in proper position.

Competent men sent to apply our rings, at cost of time and expenses.

On our next page we show an assembly of some of our products in which can be seen a new idea in the shape of a sheet metal ring rail. It is a common practice now to adjust the spindles to the rings, and adjustment of the latter is no longer necessary. With this rail, holders are dispensed with, the ring being secured direct to the rail itself. Several frames are in use giving good satisfaction. When ordering new frames consider the advisability of using this form of rail. It is simpler, stiffer, lighter, cleaner and more convenient. All cast-iron rails sag more or less. This one will not. Write us for prices.



Note Sheet Metal Ring Rail, made under patent of Geo. A. Draper.



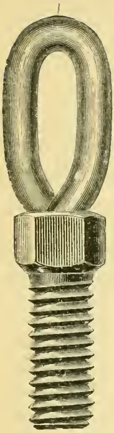
THE CULVER ROVING CLAMP.

This invention opens a wide field for experiment with prospect of important results for the future. It consists in an ingenious device attached to spinning frames for the purpose of preventing waste when an end breaks. Many inventors have tried to accomplish this result before, but so far as we know, all of them have hitherto failed to make a device that was practical enough to warrant adoption. The Culver device is already in operation on the spinning frames of a mill, and the results are startling.

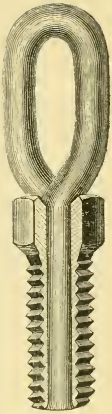
It is found that with these devices attached, a spinner can tend more spindles. There is no damage to top rolls from roving winding on them, and the waste is of course stopped. Any one of these three results will pay the probable cost. We are not taking orders as yet as the mechanical features are being improved.

We control the Culver patents together with other patents in the same line. We intend to develop an idea that will prove of great practical benefit to manufacturers, and are of course, arranging to protect ourselves from competition so far as possible. We think our patents cover all probable successful methods of accomplishing this result.

The cut simply represents an early form of device. The marketable form will probably be different in detail.



SPEAKMAN'S PATENT LEVER SCREW.



Notice the present construction—a Steel Screw and a Steel Wire—unbreakable and indestructible.

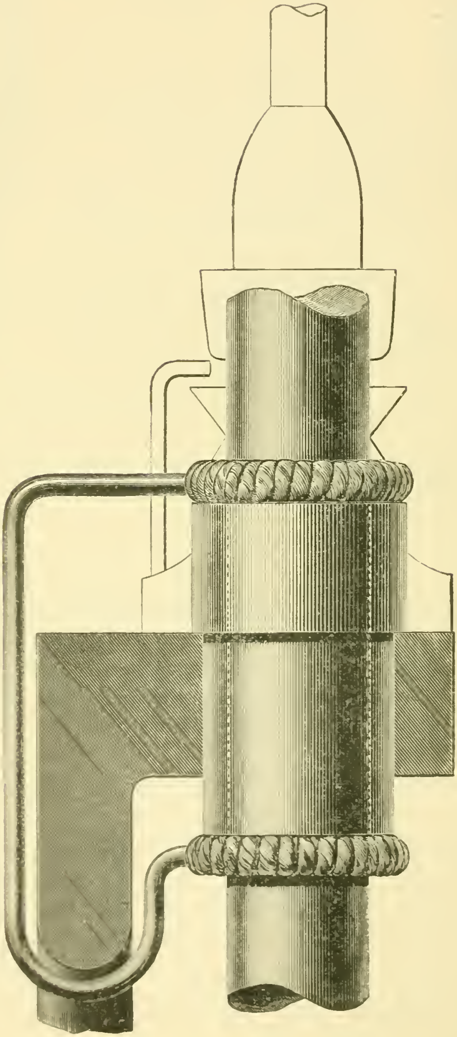
The Speakman Lever Screw is constructed of two parts, a wire hook and a screw which rotates around the hook. The wire is headed so that the upward or downward movement of the screw carries the hook up or down the same vertical distance, without, however, causing it to rotate.

On ordinary spinning and roving frames the back weight levers get out of position constantly, causing an endless source of annoyance. The only way to adjust them with the ordinary lever screw, is to stop two to four ends, take off the back weight, remove the lever from the stirrup and screw and use it as a lever to turn the screw up or down until it is properly adjusted. The disadvantages of this proceeding are known to every second hand. In the first place, the ends have to be pieced again and production is stopped from those rolls during the operation. The back weights are liable to be dropped on to the cylinder or bands, incurring a waste of time and perhaps damage. The lever will probably become bent as it was never designed as a screw driver, and the stirrup often falls between the steel rolls, making serious repairs necessary.

Compare the above operation with that in use on the Speakman screw. All that is needed is to turn the screw slightly by means of a wrench, which we provide, without stopping an end or moving a piece. With the old screw, half a turn is the least you can get, while with the Speakman as much or as little rotation as is necessary may be obtained.

Thousands of them are in use, giving universal satisfaction. Insist on having them applied to your new frames when you order them. You will make no mistake in changing over your old frames to this style. Send us a quantity order with a sample of the screw you are using, and we will cut a similar thread without extra charge.

The careful spinner is ever on the watch for real improvements, even when they are minor in results. This device is certainly superior, why not benefit by it?



SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

This simple and practical invention, which is shown in cut on opposite page, full size for three-quarter inch lifting rod, is the result of a necessity for something that will prevent the frequent stopping of lifting rods and the ring rails they carry.

Everyone familiar with the details of spinning cotton yarn knows that dirt and flyings will adhere to the lifting rods and be carried into the bushings or guides set in the frames for the rods to work in; this accumulation of dirt will wear the rods, and sooner or later is liable to stop one or more on a frame.

This attachment is made of wire, covered where it passes round the lifting rod with a twisted and braided cord which fits the rod closely, but not tight enough to cause undue friction; the elasticity of the wire and its covering prevents any liability of the rod sticking on account of collection of dirt. The two parts or covered rings are formed at the ends of one piece of wire, which is bent to pass over the back side of the rail holding the bushing through which the rods run. In forming the cleaner, sufficient spring is given to the wire to cause the rings to fit closely to the top and bottom of the bushing.

The lifting rod cleaner has been in use for years, giving satisfaction, and those who use it extensively consider it a desirable improvement. We recommend it as a cheap and convenient attachment, requiring but a moment to put on, effectually preventing wear and sticking of lifting rods, adding to the neatness of frames, and reducing the amount of oil required for lubricating the rods to the least possible quantity. They will not require oiling more than once in two or three weeks.

SPECIFICATIONS FOR ORDERING SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

Number and diameter of Lifting Rods.

Width of upper and lower rails.

Thickness of each front and back.

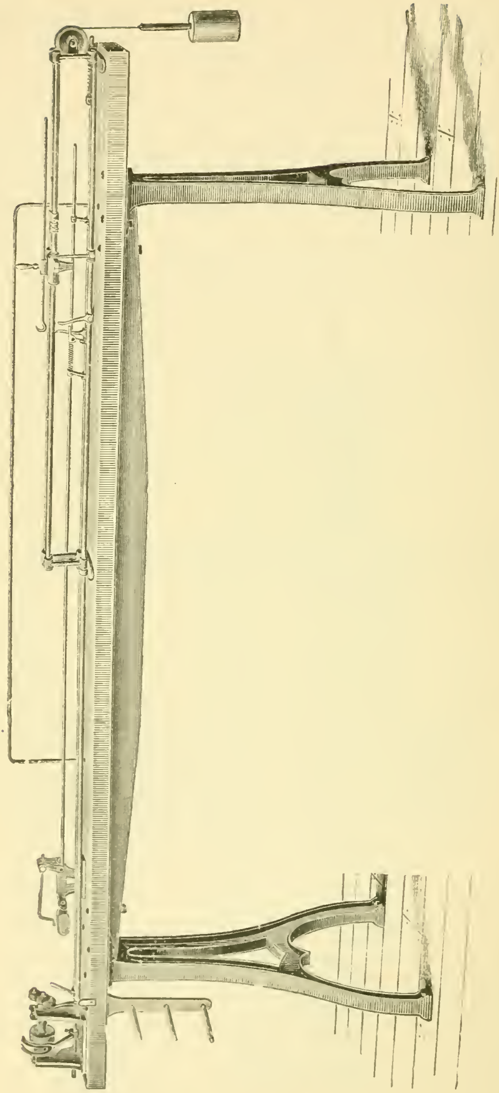
Length, small diameter, and height above rails of bushings.

Distance from back of rail to centre of rod.

If a guide for lifting rod is used below lower rail, give length where rod passes through.

The thickness of front and back of rails is wanted in case a box or flanged rail is used.

Blank specification, with diagrams for convenience in taking necessary measures, will be sent on application.



WEEKS BANDING MACHINE
With Watter's Marker.

THE WEEKS BANDING MACHINE.

We consider this the best possible machine on which to make bands for spinning and twisting frames. It is automatic in action, changing from twisting to doubling, and stopping itself when the band is done. It can be set so as to get any desired amount of twist, making a hard or soft band. The twist will always be uniform.

It is economical and simple. Bands can be made of any kind, using waste yarn or roving. We recommend the use of roving. The machine is usually run by a boy, and its capacity is only limited by the boy's skill or quickness; 1500 bands a day is by no means a maximum.

The Watters improvement is a very important additional device. Its object is to automatically make a mark at a definite length for the purpose of showing the band boy where the knot should be tied. By this means an even tension can be had on all spindles within very fine limits. This attachment is very simple and automatic, and furnishes the cheapest and most sensible method of accomplishing a long desired end. It is not an untried experiment, being in use in many of the best mills in this country. When it is understood (and it will be understood thoroughly some day), that putting a tight band on a spindle is like trying to run a railway train with the brakes on, mill men will begin to comprehend why their coal bill is such an important item. If bands of uniform proper tension were used throughout all the mills of this country, the power saved would be simply enormous.

Within a year or two we have had the entire banding machine re-designed, and in its present form, the bearings, gears and rods are all of larger size, reducing possible wear to a minimum. The cut does not show this change, as the general appearance is the same, except in size of parts.

The present machine should outwear two of the old pattern.

We sell the plain banding machine for $65, and the Watters attachment at $60 extra. While this latter price might seem high compared with the amount of cast iron used in the structure, it must be remembered that invention requires encouragement, and there is a very small field for the sale of these machines. Compared with its utility, the price for the device is absurdly low.

NEW SPINNING FRAMES.

In buying new spinning frames, important points to look after are the spindles, rings and separators. The difference between the products of the various builders is not what it used to be so far as the frame itself is concerned, and good workmanship can now be obtained from any American builder.

So far as spindles are concerned, there are but three on the market to-day. The Draper, or improved 49 D Rabbeth, is the result of years of experiment by some of the best spindle experts in the world, and we recommend it without hesitation. The Whitin is a very popular, well-designed spindle, and the McMullan has hosts of friends. Either of the three will run at any required speed, and do good work. The only questions between them are on the points of wear, power and general convenience.

As to separators, they must be of some wide-bladed form, to meet present requirements. We know of none but the Rhoades-Chandler that meets every requirement. The Chandler idea has been extensively copied. but a copy is usually inferior to the original.

As to rings, there is no question. The double flanged ring in plate holder with traveller cleaner, is almost universally used. A few still prefer common rings, but their eccentricity is an expensive luxury. We recommend the rings we sell, because we know what they are from the steel bar to the finished ring. No one is more ready to adopt improvements than we are, and we have been improving our processes of ring making for 25 years.

Weight is of great importance in a frame; proper setting up and levelling also. Cut gearing runs more smoothly than cast gears, and should be insisted on. Don't make any mistake about the traverse and size of ring. The large bobbin has come to stay.

A prominent expert on ring spinning has given us the following requirements that he would wish for in a mill of his own selection:

"Spinning frames are usually made from 160 to 224 spindles.

I prefer frames 39 inches wide, or as near that as possible. I prefer single boss rolls for all kinds of yarn, though many good spinners may differ with me.

Would have the flutes on steel rolls 1-8″ longer than the top rolls when they are covered, so as to prevent the top rolls from getting off of the flutes, and thus prevent trouble.

The clearer cloths should be hung on wires, and never glued on the boards.

Underclearers should be made of cypress or whitewood, and covered with white slasher cloth; they should be hung on weights and not on springs.

Should want iron or steel roving guide rods with brass trumpets with about 1-4″ slot, so that they can be moved slightly either way.

Should want Speakman lever screws, Dixon's latest patent lock saddles, and also a good roving guide regulator. Should want some one of the latest thread board lifters, and these should have hinges near together to prevent the boards from sagging or getting out of shape.

Creels should be made so as to give as much room for roving as possible. Creel steps or "pots" should be glass, and sunk slightly in the wood.

Should want 5 1-2″ or 6″ distance from bite of front rolls to thread guides on warp.

The right angle thread guide with a little kink arrester screwed into the door that the thread guide enters, I consider the best thing for yarns from 28s upward. This kink arrester should be screwed into the board, so as to hang directly over the inside of the flange of the ring.

The driving pulleys on frames should be at least 12″ in diameter, and the tight pulley should be about 1-4″ larger in diameter than the loose pulley. I would have a 2″ face, and where frames are belted overhead, would have a flange on the outside of the tight pulley 7-8″ wide. This will prevent the belt from running in between the frame and pulley.

Would want 6 lifting rods on a side for a frame of 160 spindles and about that proportion on other frames, rods to rest on truck rolls, with the Shaw & Flinn lifting rod cleaners applied to each.

If frames are to be warp, I would have ring rails bored for 2″ ring, for 2 3-4″ gauge frame, and if a 3″ gauge is used would have them bored to take a 2 1-4″ diameter ring. This, of course, would require at least a 3 1-4″ wide ring rail.

Should want double rings with plate holders, traveller cleaner being a part of same made so as to be self-cleaning, and for yarns under No. 28 I should not think of putting in a ring less than 1 7-8″ in diameter with a 7″ traverse. Would put in a 1 3-4″ ring and 6″ traverse on yarn from 28s to 32s. Should not think of doing this without putting on the Rhoades-Chandler separator 3 1-2″ or 4″ blade.

For fine yarns, 20s and above, would use the light No. 2 Draper spindle, and for yarns 20 and under would use the No. 4 Draper spindles 6 1-2″ and 7″ traverse.

Would have compound builder on frames, so that either warp or filling can be spun without much trouble in changing.

For change gears would want one gear each side of the one used, both for draft and twist. Would want at least 2 1-2″ distance from under side of thread guide to top of bobbins when in position on spindles; 3″ would be better for a 2″ ring and longer traverse. Rolls driven or geared all from head end of frame, work well. Top roll ends should project slightly above the cap bars, so that the waste, etc., can be removed without the use of a picker. It is next to impossible to keep ends of rolls clean when they are sunk down in the cap bars. Places should be left in the cap bars, so that the steel rolls can be oiled conveniently. I would have hole in base rail 1-16″ larger than the stem of base. This will allow a little room to adjust spindles, so that it will not be necessary to depend on the ring holder altogether.

One very important point is the bobbin. Silver birch makes a first-class spinning bobbin, both for filling and warp. For a 1 3-4″ to 2″ ring on yarns 28s and downward, the barrel of the bobbin ought to be 7-8″ diameter. It should have a steel ring or equivalent at the bottom, to prevent it from splitting. The upper bearing should never fit tight on the spindle, and should be at least 3-4″ long. The bobbin should fit the sleeve bearing from 1-2″ to 5-8″, at the same time entering the cup about an eighth of an inch. Bobbins made in this way never will rise up on the spindle. Where it is practicable the long traverse bobbin can be "bored back" at the top, leaving the walls with sufficient strength for usage. This will make the bobbin light at the top. Bobbins ought to be oiled and shellaced; the length of life of the bobbin will more than offset the difference in cost. Bobbins that are not true should be discarded altogether.

The writer knows of a case where spools made as follows were used for 21 years: The heads were made of cypress wood, barrels made of poplar wood, excavated and bushed with hard wood bushings; the heads were scant half-inch thick, sloping off the usual way 4″ diameter 5″ traverse.

This makes a light, strong spool. The heads should be shellaced, never painted. Nothing but clear stock should be used. The following dimensions make a good spool for yarns from 35s up to 50s, 4 1-2″ traverse. 7-16″ thickness for head tapered off to edge, 3 3-4″ diameter of head, 1 1-2″ barrel, same kind of wood as above. Bushings should be at least 3-4″ long to project slightly on the outside, so as to prevent spool from rubbing against side of creel.

For yarns 28s and under, I would use a 5 1-2″ to 6″ traverse and from 4″ to 4 1-2″ diameter spool head, made of the same material as the above, but would of course have the heads large, half-inch thick, tapered the usual way.

Spools and bobbins should always be shellaced, so that if poor stock is used it can be easily detected.

Filling bobbins should be made according to the diameter of ring used. The top bearing should fit loose and should be at least 3-4″ long, and an inch would be still better. They should fit the sleeve at least half an inch, same as the warp bobbins, entering the cup about an eighth of an inch.

Where filling bobbins are liable to be wet, they should be soaked in pure linseed oil and receive two coats of pure alcohol cut shellac.

Bobbins should be reamed so that they will be quite loose on the top bearing, this being simply a steadying and not an adhesive bearing."

While some of these points may seem trivial, many of them are of the utmost importance when changing to the large ring system. We know of mills where their frames have not given satisfaction, because they had not provided sufficient distance between the top of the bobbin and the guide wire. Other mills have tried to use a large ring, and failed because their bobbins were not of sufficient diameter.

The question of proper traveller has also often discouraged attempts in making these changes.

REPAIRING OLD FRAMES.

To attain the best results in modern spinning, it is not always necessary to purchase new spinning frames. Many old frames only need new spindles and a little intelligent repairing, to produce results equal to any. We have made this a special branch of our business for over twenty-three years, and can send competent men to estimate on changes required at any time.

The great mistake so often made, is in running old forms of spindles long after they should have been replaced. It makes little difference whether a Common, Pearl or Sawyer is in good condition, money is thrown away every year by running it. They cannot be run at modern speed, and they lose in production and cost of attendance, taking up more floor space than they should for a given product, and enlarging the general expense bill in every detail.

It requires very little stoppage or trouble to change spindles, and the results will show a per cent. on the investment that makes it imperative.

We make a specialty of changing over old frames to larger rings and wide-bladed separators. Mills are quick to realize the benefits from this change, and the economy is surprising.

MANAGEMENT OF THE SPINNING ROOM.

The nature of the usual spinning room help, is usually such as to require rigid supervision and discipline. The spinning department is one of the most important in the mill, and the economy of running depends in great proportion upon the skillful management of the help.

Spinning frames require accurate setting up and leveling. Probably a frame can be better leveled when set up in the mill, but in any event great care should be taken. As floors may settle in a new mill, it is well to go over the frames at stated periods and see if they need re-leveling.

In starting up new spinning frames use plenty of oil, keeping the bearings flooded until black oil is no longer found. New, and also old frames, sometimes cause considerable trouble by winding up roving on the steel rolls, thus destroying the top rolls. This is a very common evil, and our Mr. Welch's remedy is as follows:

Make a paste of whiting and animal oil that, when thoroughly mixed, "will have the consistency of hasty-pudding," then procure some pieces of card clothing about six inches square; remove the front steel roll from the frame and put it on stands made for the purpose; fill the flutes by hand with the mixture, and also fill the card clothing full of it; then have the roll scoured thoroughly by rubbing the roll lengthwise with the flutes, going over every inch at least 500 times, keeping the card well filled with the paste all the time; go over again with sawdust just the same, and clean with waste. Where the roll has been scratched in any way, a fine file should be carefully used; this should be attended to before the scouring.

Top rolls require careful attention. The custom of using a wornout front roll as a back or middle roll, is wrong. A fluted roll will make coarser yarn from the same roving, as the corrugations pass more yarn through in the same time. A damaged roll should be knifed by chopping a piece out of the covering, cloth and all, so that when re-covered it will have new cloth as well as new leather. The cloth should be of sufficient thickness to form a good cushion, and the leather should not be put on too tight. The middle roll should always be in as good condition as the front roll. There is more poor spinning made by the use of damaged top rolls than in any other manner. Iron or steel hooks should never be allowed in the spinning room. If hooks must be used they should be of brass.

Roving guides should be kept in constant movement, and never allowed to stop when the heart motion changes. This heart motion often gets worn or loose, causing the rod to have a back lash. This is damaging to the rolls, as it allows greater wear at certain portions of the traverse.

Lifting rods should work easily, and if Shaw & Flinn cleaners are applied, there will be no danger of sticking.

Spindles should be banded and run some time before adjusting the rings. Rings should always be set with the spindles running. It is of great importance to have the spindles absolutely central in the ring, and as the traverse may not be absolutely vertical, it is well to try the spindles at the bottom of the traverse as well as at the top. When a set of full bobbins of yarn are on, this can be easily watched by breaking the ends down and changing the position of the ring rails. A spindle that is central at one position of the traverse and badly out at another, should be leveled by papering up between the spindle base and the rail. Guide wires should deliver exactly over the top of the spindle, and care should be taken to adjust them properly. As new bands will stretch after use, it is well to apply them tighter than they are intended to run. A new band should pull perhaps three pounds; after running, it should pull about two pounds. Bands are very treacherous, as their tension depends on freshness, moisture, and amount of oil absorbed. Bands are put on with the frame both running and stopped. A band of course can be applied better with the frame stopped, but there is a question as to the loss of time in stopping the frame. With bands marked on a Weeks' banding machine, the band boy is less liable to make mistakes in tension.

Travelers always pull harder on new rings and also wear out faster. It is therefore advisable to use a lighter traveler at the start than will be needed later on. We believe in bands made from roving on a Weeks' banding machine. For a 39-inch width frame, about 120 to the pound will give good results. Banding is a matter of great importance. Loose bands will make slack yarn, especially if they happen to run on a spindle that is cramped or dry in its bearings. On the other hand, tight bands consume power in greater proportion than any other known cause in the mill.

New spindles need frequent oiling at the start, as for some unknown reason spindles will throw out and waste oil more in the first week than ever afterwards. Our spindles are usually oiled every two to four weeks. There is no question but what they will average to run twice as long as this, or more; but the trouble is that the boys who oil them are liable to be careless, and either skip spindles or oil some of them in such haste that the bases are not properly filled. The usual hand pours as much oil on the floor as gets in the spindle. Much of this oil runs down the base, gets on the bands, and is generally objectionable. It is evident that careful, competent help is needed here, although oil is so cheap as to appear to warrant little economy. We believe in the use of light gravity spindle oil, about 33 to 38. If an extremely light oil is used, it may actually leak through the pores of the cast iron bases. Where thick oil is used, it consumes great amounts of power, and is also more liable to gum and stick. The price of oil for a spinning room is not to be considered an instant, as the entire cost of the oil used may be saved in a few weeks at the coal pile, by proper selection. The rolls of the spinning frame require careful, regular oiling, the stated periods depending on the speed of the rolls. Great care must be taken to prevent oil getting on the working surface of either top or bottom rolls. Our expert, Mr. Welch, advises a method of oiling as follows: The spinner should have a small conical tin tube to fit the end of the finger and hold a piece of sponge in the small end. The sponge is saturated with oil and pressed on each bearing. This gives all the oil necessary for proper lubrication, and leaves no surplus to run off and get on the covering. The oil for use on top rolls should be heavier than that used for the spindles; by mixing about one-third animal oil with the spindle oil, a good lubrication can be had.

Extra top rolls should be kept in boxes made for the purpose to hold them perpendicularly, and the lid should be cushioned on the under side in such manner as to hold the rolls from damage when in transit from the roll coverer.

Bobbins should fit the sleeve of the whorl rather than the cup on our spindles, although a fit in both places is desirable. Filling bobbins often swell or warp from the moisture in the loom room, and require frequent reaming or replacement. In order to keep bobbins of uniform size, iron samples should be made to order by. These should be stamped with the name of the mill.

Care must be taken in adjusting the saddles, levers and weights so there will be no undue friction or loss of leverage. The Speakman lever screw is the best means we know of for keeping the weights in proper action.

Guide wires should be renewed when they are grooved. Frames should be kept clean, and scoured at intervals. It is well to wash the ring rails at times in a solution of lye or soda, rinsing afterwards in hot water.

It is well to have the second hand examine all the spindles in a room at intervals, to see whether any are vibrating excessively. Frequently when a spindle vibrates, it is because the bearing has worn loose. This can be easily remedied on any of our late types, by adjusting the fit of the bolster. Where the bolster is badly worn out of round, it is well to supply a new one. If careful adjustment or replacement of bolster will not help the case, the spindle blade is probably bent and a new one must be used. The second hand should also look after the banding, to see that the position of the snout or hook on the spindle base is not such as to rub and wear the band. Spindle bases should be kept clean, else the flying lint may get sucked in between the whorl and base to such extent as to actually consume power in driving the spindle. It is frequent custom in England to clean out spindle bases. We are of the opinion that this is entirely unnecessary with our spindles, providing a good, light oil is used. There will be a certain amount of grit always, but it will settle in the bottom of the base and do no damage, in our opinion. Should anyone wish to know the best method of cleaning, the one we should recommend would be taking out the bolsters and blowing them out with a steam jet or soaking them in naphtha. The bases can be cleaned with a suction pump and swab, or by means of a steam jet, provided they are taken out of the frames.

The breakage of ends on spinning frames, is a matter for serious study. An end does not break except for some good reason. The fault may, of course, be in the roving; provided that is all right, there are plenty of other chances for defects on the way to the spindle. The rolls may not be in good condition; the guide-wire may be grooved or improperly placed; the spindle may not be central with the ring, or may vibrate badly; the traveler may be worn, or a bunch of lint may be attached to the same, weighting it too heavily. Then, of course, there are general matters which may affect the whole running of the frame and no special spindle. The ring may be too large in proportion to the diameter of the bobbin; the traveler may be too light or too heavy; there may not be sufficient room between the guide-wire and the top of the traverse; the draft or twist may not be proper for the number of yarn spun; the speed of the rolls may be too great. All these matters should be within the scope of the competent spinner to remedy.

It is well for the Agent or Superintendent to keep posted on what is being done in other mills, so as to know that he is up with his neighbors. Whenever a change is thought advisable, like adopting a larger ring or longer traverse, it is well to experiment for a time with one frame before going in on a large scale. The fact that one mill is successful with a certain method, may have no effect on another, as it is almost impossible that all conditions should be alike in both cases.

RELATIVE AND ACTUAL HUMIDITY.

The condition of the air with respect to the vapor of water it contains is called its humidity. The degree of humidity is expressed as a per centage of the maximum quantity of vapor the air will contain at the temperature, and this per centage is termed its relative humidity. The actual humidity is the weight in grains per cubic foot of the vapor in the air, and it varies with the temperature for the same relative humidity. The higher the temperature, the greater quantity of vapor the air will contain. The mean relative humidity of the air at Boston, Mass., is about 70.

The relative and actual humidities of the air at ordinary temperatures may be determined from the following tables, compiled from those in use by the United States Signal Service if the difference between the temperatures of wet and dry bulb thermometers is known. *Example:* Dry Bulb, 70°; wet, 65°; difference, 5°; under 5° opposite 70° is 77 relative. 6.15 actual.

DEPRESSION OF THE WET BULB.

Temperature.	1°		2°		3°		4°		5°		6°		7°		8°	
	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R	A.	R.	A.
25	88	1.41	76	1.19	63	1.00	52	0.84	40	0.65	28	0.47	17	0.28	4	0.09
26	88	1.48	76	1.30	65	1.09	53	0.88	42	0.71	30	0.52	19	0.34	8	0.15
27	89	1.54	77	1.35	66	1.14	54	0.96	43	0.77	32	0.57	22	0.39	11	0.19
28	89	1.61	78	1.41	67	1.19	56	1.00	45	0.81	34	0.62	24	0.45	14	0.25
29	89	1.67	78	1.48	67	1.30	57	1.09	47	0.88	36	0.68	26	0.49	16	0.31
30	90	1.74	79	1.54	68	1.35	58	1.14	48	0.96	38	0.74	28	0.57	18	0.37
31	90	1.82	79	1.61	69	1.41	59	1.24	49	1.00	40	0.81	30	0.62	21	0.43
32	90	1.89	80	1.74	70	1.48	61	1.30	51	1.09	41	0.88	32	0.68	23	0.49
33	90	1.97	80	1.82	71	1.61	62	1.35	52	1.14	43	0.96	34	0.74	25	0.54
34	90	2.05	81	1.89	72	1.67	63	1.48	53	1.24	44	1.00	35	0.81	27	0.62
35	91	2.13	81	1.97	72	1.74	64	1.54	54	1.30	45	1.09	37	0.88	29	0.68
36	91	2.29	82	2.05	73	1.82	64	1.61	55	1.41	47	1.19	38	0.96	30	0.77
37	91	2.38	82	2.13	74	1.89	65	1.67	56	1.48	48	1.24	40	1.04	32	0.84
38	92	2.47	83	2.21	75	2.05	66	1.82	57	1.54	50	1.35	42	1.14	34	0.92
39	92	2.56	83	2.29	75	2.13	67	1.89	58	1.67	51	1.41	43	1.19	35	1.00
40	92	2.66	84	2.38	76	2.21	68	1.97	59	1.74	52	1.54	44	1.30	37	1.09
41	92	2.76	84	2.47	76	2.29	68	2.05	60	1.82	53	1.61	46	1.41	38	1.14
42	92	2.86	84	2.66	77	2.38	69	2.21	61	1.89	54	1.67	47	1.48	40	1.24
43	92	2.97	85	2.76	77	2.47	70	2.29	62	2.05	55	1.82	48	1.61	41	1.35
44	92	3.08	85	2.86	78	2.56	70	2.38	63	2.13	56	1.89	49	1.67	43	1.48
45	92	3.19	85	2.97	78	2.76	71	2.47	64	2.21	57	1.97	50	1.74	44	1.54
46	93	3.31	85	3.08	79	2.86	72	2.56	65	2.38	58	2.13	51	1.89	45	1.67
47	93	3.43	86	3.19	79	2.97	72	2.76	66	2.47	59	2.21	52	1.97	46	1.74
48	93	3.55	86	3.31	79	3.08	73	2.86	66	2.56	60	2.38	53	2.13	47	1.89
49	93	3.68	86	3.43	80	3.19	73	2.97	67	2.66	60	2.47	54	2.21	48	1.97
50	93	3.81	87	3.55	80	3.31	74	3.08	67	2.86	61	2.56	55	2.29	49	2.05
52	94	4.09	87	3.81	81	3.55	75	3.31	69	3.08	63	2.86	57	2.56	51	2.29
54	94	4.38	88	4.09	82	3.95	76	3.55	70	3.31	64	3.08	59	2.86	53	2.56
56	94	4.70	88	4.54	82	4.23	77	3.95	71	3.68	65	3.31	60	3.08	55	2.86
58	94	5.03	89	4.86	83	4.54	78	4.23	72	3.95	67	3.68	61	3.43	56	3.08
60	94	5.38	89	5.20	84	4.86	78	4.54	73	4.23	68	3.95	63	3.68	58	3.43
62	95	5.76	89	5.57	84	5.20	79	4.86	74	4.54	69	4.38	64	4.09	59	3.81
64	95	6.15	90	5.95	85	5.57	79	5.20	74	5.03	70	4.70	65	4.38	60	4.09
66	95	6.57	90	6.36	85	5.95	80	5.76	75	5.38	71	5.03	66	4.70	61	4.38
68	95	7.25	90	6.79	85	6.36	81	6.15	76	5.76	71	5.38	67	5.20	63	4.86
70	95	7.74	90	7.25	86	7.02	81	6.57	77	6.15	72	5.95	68	5.57	64	5.20
72	95	8.25	91	7.74	86	7.49	82	7.02	77	6.57	73	6.36	69	5.95	65	5.57
74	95	8.80	91	8.25	86	7.99	82	7.49	78	7.25	74	6.79	70	6.36	66	6.15
76	95	9.37	91	8.80	87	8.52	82	7.99	78	7.74	74	7.25	70	6.79	66	6.57
78	96	9.98	91	9.37	87	9.08	83	8.52	79	8.25	75	7.74	71	7.49	67	7.02
80	96	10.62	92	9.98	87	9.67	83	9.08	79	8.80	75	8.52	72	7.99	68	7.49
82									80	9.37	76	9.08	72	8.52	69	8.25
84									80	9.98	77	9.67	73	9.08	69	8.80
86									81	10.62	77	10.29	73	9.67	70	9.37
88									81	11.29	77	10.95	74	10.62	71	9.98
90									81	12.38	78	11.64	75	11.29	71	10.62
92									82	13.15	78	12.38	75	12.00	72	11.64
94									82	13.96	79	13.15	75	12.76	72	12.38
96									82	14.81	79	13.96	76	13.55	73	13.15
98									83	15.71	79	15.25	76	14.38	73	13.96
100									83	16.65	80	16.18	77	15.25	74	14.81
102									83	17.65	80	17.14	77	16.18	74	15.71
104									83	18.69	80	18.16	77	17.65	74	16.65
106									84	19.79	81	19.23	78	18.69	75	17.15

Temperature.	9°		10°		11°	
40	30	0.88	22	0.65	15	0.45
41	31	0.96	24	0.74	17	0.54
42	33	1.04	26	0.81	19	0.62
43	34	1.14	28	0.92	21	0.71
44	36	1.24	29	1.00	23	0.77
45	37	1.30	31	1.09	24	0.88
46	38	1.41	32	1.19	26	0.96
47	40	1.54	34	1.30	28	1.04
48	41	1.61	35	1.41	29	1.14
49	42	1.74	36	1.48	30	1.24

DEPRESSION OF THE WET BULB.

Temper-ature.	9°		10°		11°		12°		13°		14°		15°		16°	
	R.	A.	R	A.	R.	A	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.
50	43	1.82	37	1.61	32	1.35	26	1.14	21	0.88	16	0.68	10	0.43	5	0.20
51	45	1.97	39	1.74	33	1.48	28	1.24	22	1.00	17	0.77	12	0.54	7	0.31
52	46	2.05	40	1.82	35	1.61	29	1.35	24	1.09	19	0.88	13	0.62	9	0.41
53	47	2.21	41	1.97	36	1.74	31	1.48	25	1.19	20	0.96	15	0.74	10	0.49
54	48	2.29	42	2.05	37	1.82	32	1.61	27	1.30	22	1.09	17	0.84	12	0.59
55	49	2.47	43	2.21	38	1.97	33	1.74	28	1.48	23	1.19	18	0.92	14	0.71
56	50	2.56	44	2.29	39	2.05	34	1.82	30	1.61	25	1.30	20	1.04	15	0.81
57	50	2.76	45	2.47	40	2.21	36	1.97	31	1.67	26	1.41	21	1.19	17	0.92
58	51	2.86	46	2.56	42	2.38	37	2.05	32	1.82	27	1.54	23	1.30	18	1.04
59	52	2.97	47	2.76	43	2.47	38	2.21	33	1.97	29	1.67	24	1.41	20	1.19
60	53	3.19	48	2.86	44	2.66	39	2.38	34	2.13	30	1.82	25	1.54	21	1.30
61	54	3.31	49	3.08	44	2.76	40	2.47	35	2.21	31	1.97	27	1.67	22	1.41
62	54	3.43	50	3.19	45	2.97	41	2.66	37	2.38	32	2.13	28	1.82	24	1.54
63	55	3.68	51	3.31	46	3.08	42	2.76	38	2.56	33	2.29	29	1.97	25	1.67
64	56	3.81	51	3.55	47	3.19	43	2.97	38	2.66	34	2.38	30	2.13	26	1.82
65	56	3.95	52	3.68	48	3.43	44	3.08	39	2.86	35	2.56	31	2.29	27	1.97
66	57	4.09	53	3.81	49	3.55	45	3.31	40	2.97	36	2.66	32	2.38	29	2.13
67	58	4.38	53	4.09	49	3.68	45	3.43	41	3.19	37	2.86	33	2.56	30	2.29
68	58	4.54	54	4.23	50	3.95	46	3.55	42	3.31	38	3.08	34	2.76	31	2.47
69	59	4.70	55	4.38	51	4.09	47	3.81	43	3.55	39	3.19	35	2.86	32	2.66
70	60	4.86	55	4.54	52	4.23	48	3.95	44	3.68	40	3.43	36	3.08	33	2.76
72	61	5.38	57	5.03	53	4.70	49	4.38	45	4.09	42	3.68	38	3.43	35	3.19
74	62	5.76	58	5.38	54	5.03	50	4.70	47	4.38	43	4.09	40	3.81	36	3.43
76	63	6.15	59	5.95	55	5.57	52	5.20	48	4.86	45	4.54	41	4.09	38	3.81
78	63	6.79	60	6.36	56	5.95	53	5.57	49	5.20	46	4.86	43	4.54	39	4.23
80	64	7.25	61	6.79	57	6.36	54	6.15	51	5.76	47	5.38	44	5.03	41	4.70
82	65	7.74	62	7.49	58	7.02	55	6.57	52	6.15	48	5.95	45	5.57	42	5.20
84	66	8.25	63	7.99	59	7.49	56	7.25	53	6.79	49	6.36	46	5.95	44	5.57
86	67	8.80	63	8.52	60	8.25	57	7 74	54	7.25	51	7.02	48	6.57	45	6.15
88	67	9.37	64	9.08	61	8.80	58	8.25	55	7.99	52	7.49	49	7.02	46	6.57
90	68	10.29	65	9.98	62	9.37	59	9.08	56	8.52	53	7.99	50	7.74	47	7.25
92	69	10.95	65	10.62	62	9.98	59	9.67	56	9.08	54	8.80	51	8.25	48	7.74
94	69	11.64	66	11.29	63	10.95	60	10.29	57	9.98	54	9.37	52	8.80	49	8.52
96	70	12.38	67	12.00	64	11.64	61	10.95	58	10.62	55	9.98	53	9.67	50	9.08
98	70	13.55	67	12.76	64	12.38	61	12.00	59	11.29	56	10.95	53	10.29	51	9.98
100	71	14.38	68	13.55	65	13.15	62	12.76	59	12.00	57	11.64	54	10.95	51	10.62

	17°		18°		19°		20°		21°		22°		23°		24°	
70	29	2.47	26	2.21	22	1.89	19	1.61	16	1.35	12	1.04	9	0.81	6	0.54
71	30	2.66	27	2.38	23	2.05	20	1.82	17	1.48	14	1.19	10	0.92	7	0.68
72	31	2.86	28	2.56	24	2.21	21	1.97	18	1.67	15	1.35	12	1.09	9	0.81
73	32	2.97	29	2.66	25	2.38	22	2.13	19	1.82	16	1.54	13	1.24	10	0.96
74	33	3.19	30	2.86	26	2.56	23	2.29	20	1.97	17	1.67	14	1.41	11	1.09
75	34	3.31	31	3.08	27	2.76	24	2.47	21	2.13	18	1.89	15	1.54	12	1.24
76	35	3.55	31	3.19	28	2.97	25	2.66	22	2.29	19	2.05	16	1.74	14	1.41
77	35	3.81	32	3.43	29	3.08	26	2.86	23	2.47	20	2.21	17	1.89	15	1.61
78	36	3.95	33	3.68	30	3.31	27	2.97	24	2.66	21	2.38	18	2.05	16	1.82
79	37	4.23	34	3.81	31	3.55	28	3.19	25	2.86	22	2.56	19	2.29	17	1.97
80	38	4.38	35	4.09	32	3.68	29	3.43	26	3.08	23	2.76	20	2.47	18	2.13
81	38	4.54	35	4.23	33	3.95	30	3.68	27	3.31	24	2.97	21	2.66	19	2.38
82	39	4.86	36	4.54	33	4.09	31	3.81	28	3.43	25	3.19	22	2.86	20	2.56
83	40	5.03	37	4.70	34	4.38	31	4.09	29	3.68	26	3.31	23	3.08	21	2.76
84	41	5.20	38	4.86	35	4.54	32	4.23	29	3.95	27	3.55	24	3.19	22	2.97
85	41	5.57	38	5.20	36	4.86	33	4.54	30	4.09	28	3.81	25	3.43	22	3.08
86	42	5 76	39	5.38	36	5.03	34	4.70	31	4.38	29	3.95	26	3.68	23	3.31
87	42	5.95	40	5.57	37	5.20	34	4.86	32	4.54	30	4.23	27	3.81	24	3.55
88	43	6.36	40	5.95	38	5.57	35	5.20	32	4.86	30	4.54	27	4.09	25	3.81
89	44	6.57	41	6.15	38	5.76	36	5.38	33	5.03	31	4.70	28	4.38	26	3.95
90	44	6.79	41	6.36	39	6.15	36	5.76	34	5.38	32	5.03	29	4.54	26	4.23
91	45	7.25	42	6.79	39	6.36	37	5.95	35	5.57	33	5.20	30	4.86	27	4.54
92	45	7.49	43	7.02	40	6.57	37	6.15	35	5.76	33	5.38	30	5.03	28	4.70
93	46	7.74	43	7.25	41	7.02	38	6.57	36	6.15	34	5.76	31	5.38	29	5.03
94	46	7.99	44	7.74	41	7.25	39	6.79	36	6.36	34	5.95	31	5.57	29	5.20
95	47	8.25	44	7.99	42	7.49	39	7.02	37	6.57	35	6.36	32	5.95	30	5.57
96	47	8.80	45	8.25	42	7.74	40	7.49	37	7.02	36	6.57	33	6.15	30	5.76
97	48	9.08	45	8.52	43	8.25	40	7.74	38	7.25	36	6.79	33	6.36	31	5.95
98	48	9.37	46	8.80	43	8.52	41	7.99	38	7.49	37	7.25	34	6.79	32	6.36
99	49	9.67	46	9.37	44	8.80	41	8.25	39	7.99	37	7.49	34	7.02	32	6.57
100	49	9.98	47	9.67	44	9.08	42	8.80	39	8.25	37	7.74	35	7.25	33	7.02
102	50	10.95	47	10.29	45	9.98	43	9.37	40	8.80	38	8.52	36	7.99	34	7.49
104	51	11.64	48	11.29	46	10.62	44	10.29	41	9.67	39	9.08	37	8.80	35	8.25

RULES FOR SPINNERS.

To find the draught of a spinning frame:--

Write down the number of teeth in all the driving-wheels, and multiply them together. Then write down the number of teeth in all the wheels that are driven, and multiply them together in like manner. If there is any difference in the diameter of the rollers, multiply the least, or driver's product, by the diameter of the back roller; and the largest product, or that of the driven wheels, by the diameter of the front roller. Divide the product of the driven wheels by that of the drivers, and the quotient will be the draught of the machine.

To change the draught-gear on a spinning-frame when changing to a different number of yarn and the draught and roving have both to be altered:—

Multiply the number of yarn being spun, by the hank roving desired, and that product by the number of teeth in the change pinion being used; divide the product thus obtained by the number of yarn desired, multiplied by the hank roving being used. The quotient will show the change pinion required.

To change the draught gear when changing from one number of yarn to another without changing the roving:—

Multiply the number of teeth in the change pinion in use by the number of yarn spun. This product divided by the number of yarn desired will give the change pinion required.

To change the twist-gear when changing to a different number of yarn:—

Square the number of teeth in the present gear, and multiply by the number of yarn being spun. Divide this product by the number of the yarn desired; the square root of the quotient will show the proper number of teeth for the new gear.

To find what per cent. yarn contracts in twisting:—

Divide the number of the yarn by the product of the draught and hank roving, and subtract the quotient from 1. *Example*: Suppose No. 28.5 yarn is being spun from 4-hank roving, with a draught of 7.26. 7.26× 4=29.04. 28.5÷29.4=0.98, which subtracted from 1.00 leaves .02, or two per cent=the contraction in length.

To find the loss of twist in spinning:—

By the "loss of twist" is meant the amount the actual twist is less than that found by computing from the speed of the spindle. *Rule:* Divide 1 by the circumference of the bobbin in inches. *Example:* Suppose a filling bobbin is 1½ inches in circumference at the barrel. 1÷1.5=0.67=loss there. If it is 3 inches in circumference at the outside the loss there=1÷3=0.33. Average loss from computed twist 0.50, or half a turn per inch.

The best way to find the actual speed of spindles:—

Make some mark on the end of the cylinder so an assistant can turn it by hand slowly just once around. Mark the heads of several bobbins, or mark the whirls of the spindles, so as to be able to count the average number of turns of the spindle to one turn of the cylinder. Then multiply this number by the revolutions per minute the cylinder makes, ascertained carefully with a good speed-counter; or attach revolving-shaft of a speed-counter to tip of spindle with a rubber tube.

The result obtained by either of these methods is nearer the actual speed of the spindle than the result obtained from computation in the usual way, because of the differences due to the size of the banding and the angle of the groove in the whirl.

To find the length of yarn in a bobbin:—

Multiply the circumference of the front roll in inches by the number of revolutions per minute, and this product by the number of minutes required to fill the bobbin; divide by 36 and deduct the contraction in twisting, and the result will be the number of yarns on the bobbin.

Avoirdupois Weight.

Grains.		Drachms.		Ounces.		Pounds.		Ton.		Grammes.		Kilog.
27.34	=	1							=	1.77184		
437.5	=	16	=	1					=	28.34954		
7,000.0	=	256	=	16	=	1			=	453.59265		
						2000	=	1			=	907.18

Long Measure.

Inches.		Feet.		Yards.		Rods.		Furlongs.	Mile.		Metres.
12	=	1								=	.3048
36	=	3	=	1						=	.9144
198	=	16.5	=	5.5	=	1				=	5.0291
7,920	=	660	=	220	=	40	=	1		=	201.1643
63,360	=	5,280	=	1,760	=	320	=	8	1	=	1,609.3145

DIMENSIONS OF CIRCLES.

Diameter.		Circumference.	Area.	Diameter.		Circumference.	Area.
1-64	.015625	.04909	.00019	3-4	.75	2.35619	.44179
1-32	.03125	.09817	.00077	25-32	.78125	2.45437	.47937
3-64	.046875	.14726	.00173	13-16	.8125	2.55254	.51849
1-16	.0625	.19635	.00307	27-32	.84375	2.65072	.55914
3-32	.09375	.29452	.00690	7-8	.875	2.74889	.60132
1-8	.125	.39270	.01227	29-32	.90625	2.84707	.64504
5-32	.15625	.49087	.01917	15-16	.9375	2.94524	.69029
3-16	.1875	.58905	.02761	31-32	.96875	3.04342	.73708
7-32	.21875	.68722	.03758	**1**	**1.**	**3.14159**	**.78540**
1-4	.25	.78540	.04909	1-16	1.0625	3.33794	.88664
9-32	.28125	.88357	.06213	1-8	1.125	3.53429	.99402
5-16	.3125	.98175	.07670	3-16	1.1875	3.73064	1.1075
11-32	34375	1.07992	.09281	1-4	1.25	3.92699	1.2272
3-8	.375	1.17810	.11045	5-16	1.3125	4.12334	1.3530
13-32	.40625	1.27627	.12962	3-8	1.375	4 31969	1.4849
7-16	.4375	1.37445	.15033	7-16	1.4375	4.51604	1.6230
15-32	.46875	1.47262	.17257	1-2	1.5	4.71239	1.7671
1-2	.5	1.57080	.19635	9-16	1.5625	4.90874	1.9175
17-32	.53125	1.66897	.22166	5-8	1.625	5.10509	2.0739
9-16	.5625	1.76715	.24850	11-16	1.6875	5.30144	2.2365
19-32	.59375	1.86532	.27688	3-4	1.75	5.49779	2.4053
5-8	.625	1.96350	.30680	13-16	1.8125	5.69414	2.5802
21-32	.65625	2.06167	.33824	7-8	1.875	5.89049	2.7612
11-16	.6875	2.15984	.37122	15-16	1.9375	6.08684	2.9483
23-32	.71875	2.25802	.40574	**2**	**2.**	**6.28319**	**3.1416**

NUMBERING YARNS.

Yarn is weighed by avoirdupois weight.

Silk.

The silk-worm forms the cocoon of two parallel filaments of silk; three to six cocoons are usually reeled off together, making a thread of raw silk containing six to twelve filaments. One authority states that 500 yards of five twin filaments weigh about 2.5 grains. The number of drachms (27.34 grains) that 1000 yards of this raw silk weighs is the number.

Silk is sold in the United States by the number of yards in one ounce.

Sewing silk is numbered irregularly by letters:

Letter,	000	00	0	A	B	C	D	E	EE	F	FF	G
Yards in one oz.,	2000	1600	1300	1000	850	650	550	400	330	262	212	125

Letter A silk has 16,000 yards in a pound, and equals about a No. 60 cotton sewing thread in weight.

Silk that cannot be reeled is carded, spun and numbered like cotton yarn, and is called spun silk.

Linen and Jute.

Barlow's History of Weaving, London (1878), gives the following table:

2½ yards = 1 thread or round of the linen reel.
300 " = 120 " = 1 cut.
600 " = 240 " = 2 " = 1 heer.
1,800 " = 720 " = 6 " = 3 " = 1 slip.
3,600 " = 1,440 " = 12 " = 6 " = 2 " = 1 hank.
7,200 " = 2,880 " = 24 " = 12 " = 4 " = 2 " = 1 hasp.
14,400 " = 5,760 " = 48 " = 24 " = 8 " = 4 " = 2 " = 1 spyndle.

The number of cuts in one pound is the number of linen yarn.

The number of yards of linen yarn that weigh 23.33 grains is the number of the yarn.

The numbers by which linen sewing threads are sold represent three threads of the number twisted together, that is, No. 35 standard thread has three strands of No. 35 yarn in it.

Table for numbering Linen Yarn by the weight in grains of 300 yards or 1 lea (or cut).

Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.
100	70.	260	26.92	420	16.67	580	12.07	800	8.75	1500	4.67
110	63.64	270	25.93	430	16.28	590	11.86	825	8.48	1600	4.37
120	58.33	280	25.	440	15.91	600	11.67	850	8.24	1700	4.12
130	53.85	290	24.14	450	15.56	610	11.48	875	8.	1800	3.89
140	50.	300	23.33	460	15.22	620	11.29	900	7.78	1900	3.68
150	46.67	310	22.58	470	14.89	630	11.11	925	7.57	2000	3.50
160	43.75	320	21.87	480	14.58	640	10.94	950	7.37	2250	3.11
170	41.18	330	21.21	490	14.29	650	10.77	975	7.18	2500	2.80
180	38.89	340	20.59	500	14.	660	10.61	1000	7.	2750	2.55
190	36.84	350	20.	510	13.73	670	10.45	1050	6.67	3000	2.33
200	35.	360	19.44	520	13.46	680	10.29	1100	6.36	3250	2.15
210	33.33	370	18.92	530	13.21	690	10.14	1150	6.09	3500	2.
220	31.82	380	18.42	540	12.96	700	10.	1200	5.83	4000	1.75
230	30.43	390	17.95	550	12.73	725	9.66	1250	5.60	5000	1.40
240	29.17	400	17.50	560	12.50	750	9.33	1300	5.38	6000	1.17
250	28.	410	17.07	570	12.28	775	9.03	1400	5.	7000	1.

Woollen.

1 yard=1 thread or round of the woollen reel.
80 " =1 knot.
300 " =3¾ " =1 cut.
1,600 " =20 " =5⅓ " =1 run.
2,000 " =25 " =6⅔ " =1¼ " =1 bier.

The number of runs in one pound is the number of woollen yarn.

The number of yards of woollen yarn that weigh 4.375 grains is the number of the yarn.

Table for numbering Woollen Yarn by the weight in grains of twenty yards, or one fourth of a knot

Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.
1	87.50	18	4.86	35	2.50	52	1.68	69	1.27	86	1.02
2	43.75	19	4.61	36	2.43	53	1.65	70	1.25	87	1.01
3	29.17	20	4.37	37	2.36	54	1.62	71	1.23	88	.99
4	21.87	21	4.17	38	2.30	55	1.59	72	1.22	89	.98
5	17.50	22	3.98	39	2.24	56	1.56	73	1.20	90	.97
6	14.58	23	3.80	40	2.19	57	1.54	74	1.18	91	.96
7	12.50	24	3.65	41	2.13	58	1.51	75	1.17	92	.95
8	10.94	25	3.50	42	2.08	59	1.48	76	1.15	93	.94
9	9.72	26	3.37	43	2.03	60	1.46	77	1.14	94	.93
10	8.75	27	3.24	44	1.99	61	1.43	78	1.12	95	.92
11	7.95	28	3.12	45	1.94	62	1.41	79	1.11	96	.91
12	7.29	29	3.02	46	1.90	63	1.38	80	1.09	97	.90
13	6.73	30	2.92	47	1.86	64	1.37	81	1.08	98	.89
14	6.25	31	2.82	48	1.82	65	1.35	82	1.07	99	.88
15	5.83	32	2.73	49	1.79	66	1.33	83	1.05	100	.87
16	5.47	33	2.65	50	1.75	67	1.31	84	1.04		
17	5.15	34	2.57	51	1.72	68	1.29	85	1.03		

The number of yarn of different sizes represents the proportionate size of No. 1 yarn, and to determine the size or number of a thread composed of strands of different numbers twisted together, it is only necessary to add together the proportionate sizes of the separate strands. A single example will illustrate: 3 run, 4 run, 5 run and 6 run twisted together will make yarn the size of $\frac{1}{3}\times\frac{1}{4}\times\frac{1}{5}\times\frac{1}{6}$ of 1 run, or $\frac{20}{60}\times\frac{15}{60}\times\frac{12}{60}\times\frac{10}{60}=\frac{57}{60}$ of 1 run; not quite so large as one run, but exactly 60÷57=1.05 run.

Worsted.

1 yard, =1 thread or round of the worsted reel.
80 " =80 " =1 lea or knot.
560 " =560 " =7 " " =1 hank.

The number of hanks in one pound is the number of worsted yarn.

The number of a worsted yarn of a given length which equals in weight a cotton yarn of the same length, is equal to the cotton number multiplied by 1.5. No. 60 cotton No. 90 worsted.

The number of yards of worsted yarn that weigh 12.5 grains is the number of the yarn.

Table for numbering Worsted Yarn by the weight in grains of twenty yards, or one fourth of a knot.

Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.
1	250.	19	13.16	37	6.76	55	4.55	73	3.42	91	2.75
2	125.	20	12.50	38	6.58	56	4.46	74	3.38	92	2.72
3	83.33	21	11.90	39	6.41	57	4.39	75	3.33	93	2.69
4	62.50	22	11.36	40	6.25	58	4.31	76	3.29	94	2.66
5	50.	23	10.87	41	6.10	59	4.24	77	3.25	95	2.63
6	41.67	24	10.42	42	5.95	60	4.17	78	3.21	96	2.60
7	35.71	25	10.	43	5.81	61	4.10	79	3.17	97	2.58
8	31.25	26	9.62	44	5.68	62	4.03	80	3.12	98	2.55
9	27.78	27	9.26	45	5.56	63	3.97	81	3.09	99	2.52
10	25.	28	8.93	46	5.43	64	3.91	82	3.05	100	2.50
11	22.73	29	8.62	47	5.32	65	3.85	83	3.01	105	2.38
12	20.83	30	8.33	48	5.21	66	3.79	84	2.98	110	2.27
13	19.23	31	8.06	49	5.10	67	3.73	85	2.94	115	2.17
14	17.86	32	7.81	50	5.	68	3.68	86	2.91	120	2.08
15	16.67	33	7.58	51	4.90	69	3.62	87	2.87	125	2.
16	15.62	34	7.35	52	4.81	70	3.57	88	2.84	150	1.67
17	14.71	35	7.14	53	4.72	71	3.52	89	2.81	175	1.43
18	13.89	36	6.94	54	4.63	72	3.47	90	2.78	200	1.25

Cotton.

1½ yards =1 thread or round of the cotton reel.
120 " =80 " =1 skein, ley or lea.
840 " =560 " =7 skeins=1 hank.

The number of hanks in one pound, is the number of cotton yarn.

The number of yards of cotton yarn that weigh 8.33 grains, is the number of the yarn.

The numbers by which cotton sewing threads are sold represent three threads of the number twisted together, that is, No. 60 standard thread has three strands of No. 60 yarn in it. In a six-cord thread each of the three strands is made up of two threads twisted together. Six threads of No. 120 make six-cord No. 60.

The French system of numbering is based on the Metric system. The metre=39.37 inches, and is the standard of length. The kilogram (2.2047 pounds) is the standard weight in numbering yarn, and the number of thousand metres in a kilogram is the number of the yarn. No. 28 yarn would be No. 47.42 in France.

By the various standards, No. 1 yarn has the following numbers of yards in one pound:

Cotton and spun silk	840
Linen	300
Woollen	1,600
Worsted	560

The following tables have been carefully computed, and are, we believe, correct.

The tables for numbering cotton yarn by the weight of one skein are also printed separately for the use of spinners, and we will mail a copy to any overseer who will send to us for it, and give his address plainly written.

BREAKING WEIGHT OF AMERICAN WARP YARNS.

This table given below was made up in July, 1886, after testing samples from over 225 representative mills. We know of no other table so complete or satisfactory.

Breaking weight of American Warp Yarns, per skein. Weight given in pounds and tenths.

Number.	Breaking Weight.	Number.	Breaking Weight.	Number.	Breaking Weight.	Number.	Breaking Weight.	Number.	Breaking Weight.
		20	88.3	**40**	44.6	**60**	31.7	**80**	24.6
1		21	83.8	41	43.8	61	31.3	81	24.3
2		22	79.7	42	43.0	62	30.8	82	24.0
3	530.0	23	75.9	43	42.2	63	30.4	83	23.7
4	410.0	24	72.4	44	41.4	64	30.0	84	23.4
5	330.0	25	69.2	45	40.7	65	29.6	85	23.2
6	275.0	26	66.3	46	40.0	66	29.2	86	22.8
7	237.6	27	63.6	47	39.3	67	28.8	87	22.6
8	209.0	28	61.3	48	38.6	68	28.5	88	22.4
9	186.5	29	59.2	49	37.9	69	28.2	89	22.2
10	168.7	**30**	57.3	**50**	37.3	**70**	27.8	**90**	22.0
11	154.1	31	55.6	51	36.6	71	27.4	91	21.7
12	142.0	32	54.0	52	36.1	72	27.1	92	21.5
13	131.5	33	52.6	53	35.5	73	26.8	93	21.3
14	122.8	34	51.2	54	34.9	74	26.5	94	21.2
15	115.1	35	50.0	55	34.4	75	26.2	95	21.0
16	108.4	36	48.7	56	33.8	76	25.8	96	20.7
17	102.5	37	47.6	57	33.4	77	25.5	97	20.5
18	97.3	38	46.5	58	32.8	78	25.3	98	20.4
19	92.6	39	45.5	59	32.3	79	24.9	99	20.2
								100	20.0

The table on the next page is prepared from figures collected by Mr. Louis Simpson, general manager of the Montreal Cotton Co., through friends in England. The only former printed statistics are the table of Hyde printed in 1867, and the table of Lancaster printed in 1892. The Lancaster table is evidently based on Hyde's figures, and both are so far below present standards as to be of little use.

Warp yarn is spun on both Mules and Frames in England, Mules being in far larger proportion. We found the variation between the two so slight as affecting the strength of the yarn as not to warrant division. We also found the variation between Egyptian and Best American cotton too slight for sub-division. The Egyptian is slightly ahead.

BREAKING WEIGHT OF ENGLISH WARP YARN GIVEN IN POUNDS.

Number of Yarn.	Ordinary Cotton.			Long Stapled. Egyptian or American.		
	Com.	Fair.	Super.	Com.	Fair.	Super.
12	135	155	185	....	....	....
16	90	100	112	....	....	....
20	75	85	98	....	....	....
26	60	68	78	80	90	100
30	50	55	62	70	80	90
32	45	50	58	65	75	85
36	40	46	53	52	60	68
40	36	40	44	50	55	60
50	....	....	....	40	45	50
60	....	....	....	30	33	37
70	....	....	....	26	28	31
80	....	....	....	20	22	25

So far as comparison with our American table is concerned, we have no sub-division into grades, our table showing a general average. Our yarn is slightly better than their "Fair" grade from ordinary cotton.

Comparative Numbers of Yarn of different materials of the same weight per yard.

Cot.	Woollen.	Worst.	Linen.	Silk.	Cot.	Woollen.	Worst.	Linen.	Silk.
Hanks of 840 yards.	Runs of 1,600 yards.	Hanks of 560 yards.	Cuts of 300 yards.	Yards in one ounce.	Hanks of 840 yards.	Runs of 1,600 yards.	Hanks of 560 yards.	Cuts of 300 yards.	Yards in one ounce.
1	.525	1.5	2.8	52.5	71	37.275	106.5	198.8	3727.5
2	1.05	3.	5.6	105.	72	37.8	108.	201.6	3780.
3	1.575	4.5	8.4	157.5	73	38.325	109.5	204.4	3832.5
4	2.1	6.	11.2	210.	74	38.85	111.	207.2	3885.
5	2.625	7.5	14.	262.5	75	39.375	112.5	210.	3937.5
6	3.15	9.	16.8	315.	76	39.9	114.	212.8	3990.
7	3.675	10.5	19.6	367.5	77	40.425	115.5	215.6	4042.5
8	4.2	12.	22.4	420.	78	40.95	117.	218.4	4095.
9	4.725	13.5	25.2	472.5	79	41.475	118.5	221.2	4147.5
10	5.25	15.	28.	525.	**80**	42.	120.	224.	4200.
11	5.775	16.5	30.8	577.5	81	42.525	121.5	226.8	4252.5
12	6.3	18.	33.6	630.	82	43.05	123.	229.6	4305.
13	6.825	19.5	36.4	682.5	83	43.575	124.5	232.4	4357.5
14	7.35	21.	39.2	735.	84	44.1	126.	235.2	4410.
15	7.875	22.5	42.	787.5	85	44.625	127.5	238.	4462.5
16	8.4	24.	44.8	840.	86	45.15	129.	240.8	4515.
17	8.925	25.5	47.6	892.5	87	45.675	130.5	243.6	4567.5
18	9.45	27.	50.4	945.	88	46.2	132.	246.4	4620.
19	9.975	28.5	53.2	997.5	89	46.725	133.5	249.2	4672.5
20	10.5	30.	56.	1050.	**90**	47.25	135.	252.	4725.
21	11.025	31.5	58.8	1102.5	91	47.775	136.5	254.8	4777.5
22	11.55	33.	61.6	1155.	92	48.3	138.	257.6	4830.
23	12.075	34.5	64.4	1207.5	93	48.825	139.5	260.4	4882.5
24	12.6	36.	67.2	1260.	94	49.35	141.	263.2	4935.
25	13.125	37.5	70.	1312.5	95	49.875	142.5	266.	4987.5
26	13.65	39.	72.8	1365.	96	50.4	144.	268.8	5040.
27	14.175	40.5	75.6	1417.5	97	50.925	145.5	271.6	5092.5
28	14.7	42.	78.4	1470.	98	51.45	147.	274.4	5145.
29	15.225	43.5	81.2	1522.5	99	51.975	148.5	277.2	5197.5
30	15.75	45.	84.	1575.	**100**	52.5	150.	280.	5250.
31	16.275	46.5	86.8	1627.5	101	53.025	151.5	282.8	5302.5
32	16.8	48.	89.6	1680.	102	53.55	153.	285.6	5355.
33	17.325	49.5	92.4	1732.5	103	54.075	154.5	288.4	5407.5
34	17.85	51.	95.2	1785.	104	54.6	156.	291.2	5460.
35	18.375	52.5	98.	1837.5	105	55.125	157.5	294.	5512.5
36	18.9	54.	100.8	1890.	106	55.65	159.	296.8	5565.
37	19.425	55.5	103.6	1942.5	107	56.175	160.5	299.6	5617.5
38	19.95	57.	106.4	1995.	108	56.7	162.	302.4	5670.
39	20.475	58.5	109.2	2047.5	109	57.225	163.5	305.2	5722.5
40	21.	60.	112.	2100.	**110**	57.75	165.	308.	5775.
41	21.525	61.5	114.8	2152.5	111	58.275	166.5	310.8	5827.5
42	22.05	63.	117.6	2205.	112	58.8	168.	313.6	5880.
43	22.575	64.5	120.4	2257.5	113	59.325	169.5	316.4	5932.5
44	23.1	66.	123.2	2310.	114	59.85	171.	319.2	5985.
45	23.625	67.5	126.	2362.5	115	60.375	173.5	322.	6037.5
46	24.15	69.	128.8	2415.	116	60.9	174.	324.8	6090.
47	24.675	70.5	131.6	2467.5	117	61.425	175.5	327.6	6142.5
48	25.2	72.	134.4	2520.	118	61.95	177.	330.4	6195.
49	25.725	73.5	137.2	2572.5	119	62.475	178.5	333.2	6247.5
50	26.25	75.	140.	2625.	**120**	63.	180.	336.	6300.
51	26.775	76.5	142.8	2677.5	121	63.525	181.5	338.8	6352.5
52	27.3	78.	145.6	2730.	122	64.05	183.	341.6	6405.
53	27.825	79.5	148.4	2782.5	123	64.575	184.5	344.4	6457.5
54	28.35	81.	151.2	2835.	124	65.1	186.	347.2	6510.
55	28.875	82.5	154.	2887.5	125	65.625	187.5	350.	6562.5
56	29.4	84.	156.8	2940.	126	66.15	189.	352.8	6615.
57	29.925	85.5	159.6	2992.5	127	66.675	190.5	355.6	6667.5
58	30.45	87.	162.4	3045.	128	67.2	192.	358.4	6720.
59	30.975	88.5	165.2	3097.5	129	67.725	193.5	361.2	6772.5
60	31.5	90.	168.	3150.	**130**	68.25	195.	364.	6825.
61	32.025	91.5	170.8	3202.5	131	68.775	196.5	366.8	6877.5
62	32.55	93.	173.6	3255.	132	69.3	198.	369.6	6930.
63	33.075	94.5	176.4	3307.5	133	69.825	199.5	372.4	6982.5
64	33.6	96.	179.2	3360.	134	70.35	201.	375.2	7035.
65	34.125	97.5	182.	3412.5	135	70.875	202.5	378.	7087.5
66	34.65	99.	184.8	3465.	136	71.4	204.	380.8	7140.
67	35.175	100.5	187.6	3517.5	137	71.925	205.5	383.6	7192.5
68	35.7	102.	190.4	3570.	138	72.45	207.	386.4	7245.
69	36.225	103.5	193.2	3622.5	139	72.975	208.5	389.2	7297.5
70	36.75	105.	196.	3675.	**140**	73.5	210.	392.	7350.

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains	Number of Yarn	120yds. weigh grains.	Number of Yarn.
1.	1000.	**14.**	71.43	**21**	47.62	**28.**	35.71	**35.**	28.57
2.	500.	.1	70.92	.1	47.39	.1	35.59	.1	28.49
3.	333.3	.2	70.42	.2	47.17	.2	35.46	.2	28.41
4.	250.0	.3	69.93	.3	46.95	.3	35.34	.3	28.33
5.	200.0	.4	69.44	.4	46.73	.4	35.21	.4	28.25
5.5	181.8	.5	68.97	.5	46.51	.5	35.09	.5	28.17
6.	166.7	.6	68.49	.6	46.30	.6	34.97	.6	28.09
6.5	153.8	.7	68.03	.7	46.08	.7	34.84	.7	28.01
7.	142.9	.8	67.57	.8	45.87	.8	34.72	.8	27.93
7.5	133.3	.9	67.11	.9	45.66	.9	34.60	.9	27.86
8.	125.0	**15.**	66.67	**22.**	45.45	**29.**	34.48	**36.**	27.78
.1	123.5	.1	66.23	.1	45.25	.1	34.36	.1	27.70
.2	122.0	.2	65.79	.2	45.05	.2	34.25	.2	27.62
.3	120.5	.3	65.36	.3	44.84	.3	34.13	.3	27.55
.4	119.0	.4	64.94	.4	44.64	.4	34.01	.4	27.47
.5	117.6	.5	64.52	.5	44.44	.5	33.90	.5	27.40
.6	116.3	.6	64.10	.6	44.25	.6	33.78	.6	27.32
.7	114.9	.7	63.69	.7	44.05	.7	33.67	.7	27.25
.8	113.6	.8	63.29	.8	43.86	.8	33.56	.8	27.17
.9	112.4	.9	62.89	.9	43.67	.9	33.44	.9	27.10
9.	111.1	**16.**	62.50	**23.**	43.48	**30.**	33.33	**37.**	27.03
.1	109.9	.1	62.11	.1	43.29	.1	33.22	.1	26.95
.2	108.7	.2	61.73	.2	43.10	.2	33.11	.2	26.88
.3	107.5	.3	61.35	.3	42.92	.3	33.00	.3	26.81
.4	106.4	.4	60.98	.4	42.74	.4	32.89	.4	26.74
.5	105.3	.5	60.61	.5	42.55	.5	32.79	.5	26.67
.6	104.2	.6	60.24	.6	42.37	.6	32.68	.6	26.60
.7	103.1	.7	59.88	.7	42.19	.7	32.57	.7	26.53
.8	102.0	.8	59.52	.8	42.02	.8	32.47	.8	26.46
.9	101.0	.9	59.17	.9	41.84	.9	32.36	.9	26.39
10	100.0	**17.**	58.82	**24.**	41.67	**31.**	32.26	**38.**	26.32
.1	99.01	.1	58.48	.1	41.49	.1	32.16	.1	26.25
.2	98.04	.2	58.14	.2	41.32	.2	32.05	.2	26.18
.3	97.09	.3	57.80	.3	41.15	.3	31.95	.3	26.11
.4	96.15	.4	57.47	.4	40.98	.4	31.85	.4	26.04
.5	95.24	.5	57.14	.5	40.82	.5	31.75	.5	25.97
.6	94.34	.6	56.82	.6	40.65	.6	31.65	.6	25.91
.7	93.46	.7	56.50	.7	40.49	.7	31.55	.7	25.84
.8	92.59	.8	56.18	.8	40.32	.8	31.45	.8	25.77
.9	91.74	.9	55.87	.9	40.16	.9	31.35	.9	25.71
11.	90.91	**18.**	55.56	**25.**	40.00	**32.**	31.25	**39.**	25.64
.1	90.09	.1	55.25	.1	39.84	.1	31.15	.1	25.58
.2	89.29	.2	54.95	.2	39.68	.2	31.06	.2	25.51
.3	88.50	.3	54.64	.3	39.53	.3	30.96	.3	25.45
.4	87.72	.4	54.35	.4	39.37	.4	30.86	.4	25.38
.5	86.96	.5	54.05	.5	39.22	.5	30.77	.5	25.32
.6	86.21	.6	53.76	.6	39.06	.6	30.67	.6	25.25
.7	85.47	.7	53.48	.7	38.91	.7	30.58	.7	25.19
.8	84.75	.8	53.19	.8	38.76	.8	30.49	.8	25.13
.9	84.03	.9	52.91	.9	38.61	.9	30.40	.9	25.06
12.	83.33	**19.**	52.63	**26.**	38.46	**33.**	30.30	**40.**	25.00
.1	82.64	.1	52.36	.1	38.31	.1	30.21	.1	24.94
.2	81.97	.2	52.08	.2	38.17	.2	30.12	.2	24.88
.3	81.30	.3	51.81	.3	38.02	.3	30.03	.3	24.81
.4	80.65	.4	51.55	.4	37.88	.4	29.94	.4	24.75
.5	80.00	.5	51.28	.5	37.74	.5	29.85	.5	24.69
.6	79.37	.6	51.02	.6	37.59	.6	29.76	.6	24.63
.7	78.74	.7	50.76	.7	37.45	.7	29.67	.7	24.57
.8	78.12	.8	50.51	.8	37.31	.8	29.59	.8	24.51
.9	77.52	.9	50.25	.9	37.17	.9	29.50	.9	24.45
13.	76.92	**20.**	50.00	**27.**	37.04	**34.**	29.41	**41.**	24.39
.1	76.34	.1	49.75	.1	36.90	.1	29.33	.1	24.33
.2	75.76	.2	49.50	.2	36.77	.2	29.24	.2	24.27
.3	75.19	.3	49.26	.3	36.63	.3	29.15	.3	24.21
.4	74.63	.4	49.02	.4	36.50	.4	29.07	.4	24.15
.5	74.07	.5	48.78	.5	36.36	.5	28.99	.5	24.10
.6	73.53	.6	48.54	.6	36.23	.6	28.90	.6	24.04
.7	72.99	.7	48.31	.7	36.10	.7	28.82	.7	23.98
.8	72.46	.8	48.08	.8	35.97	.8	28.74	.8	23.92
.9	71.94	.9	47.85	.9	35.84	.9	28.65	.9	23.87

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds weigh grains.	Number of Yarn.
42.	23.81	**49.**	20.41	**56.**	17.86	**63.**	15.87	**70.**	14.29
.1	23.75	.1	20.37	.1	17.83	.1	15.85	.1	14.27
.2	23.70	.2	20.33	.2	17.79	.2	15.83	.2	14.25
.3	23.64	.3	20.28	.3	17.76	.3	15.80	.3	14.22
.4	23.58	.4	20.24	.4	17.73	.4	15.77	.4	14.20
.5	23.53	.5	20.20	.5	17.70	.5	15.75	.5	14.18
.6	23.47	.6	20.16	.6	17.67	.6	15.72	.6	14.16
.7	23.42	.7	20.12	.7	17.64	.7	15.70	.7	14.14
.8	23.36	.8	20.08	.8	17.61	.8	15.67	.8	14.12
.9	23.31	.9	20.04	.9	17.57	.9	15.65	.9	14.10
43.	23.26	**50.**	20.00	**57.**	17.54	**64.**	15.62	**71.**	14.08
.1	23.20	.1	19.96	.1	17.51	.1	15.60	.1	14.06
.2	23.15	.2	19.92	.2	17.48	.2	15.58	.2	14.04
.3	23.09	.3	19.88	.3	17.45	.3	15.55	.3	14.03
.4	23.04	.4	19.84	.4	17.42	.4	15.53	.4	14.01
.5	22.99	.5	19.80	.5	17.39	.5	15.50	.5	13.99
.6	22.94	.6	19.76	.6	17.36	.6	15.48	.6	13.97
.7	22.88	.7	19.72	.7	17.33	.7	15.46	.7	13.95
.8	22.83	.8	19.69	.8	17.30	.8	15.43	.8	13.93
.9	22.78	.9	19.65	.9	17.27	.9	15.41	.9	13.91
44.	22.73	**51.**	19.61	**58.**	17.24	**65.**	15.38	**72.**	13.89
.1	22.68	.1	19.57	.1	17.21	.1	15.36	.1	13.87
.2	22.62	.2	19.53	.2	17.18	.2	15.34	.2	13.85
.3	22.57	.3	19.49	.3	17.15	.3	15.31	.3	13.83
.4	22.52	.4	19.46	.4	17.12	.4	15.29	.4	13.81
.5	22.47	.5	19.42	.5	17.09	.5	15.27	.5	13.79
.6	22.42	.6	19.38	.6	17.06	.6	15.24	.6	13.77
.7	22.37	.7	19.34	.7	17.04	.7	15.22	.7	13.76
.8	22.32	.8	19.31	.8	17.01	.8	15.20	.8	13.74
.9	22.27	.9	19.27	.9	16.98	.9	15.17	.9	13.72
45.	22.22	**52.**	19.23	**59.**	16.95	**66.**	15.15	**73.**	13.70
.1	22.17	.1	19.19	.1	16.92	.1	15.13	.1	13.68
.2	22.12	.2	19.16	.2	16.89	.2	15.11	.2	13.66
.3	22.08	.3	19.12	.3	16.86	.3	15.08	.3	13.64
.4	22.03	.4	19.08	.4	16.84	.4	15.06	.4	13.62
.5	21.98	.5	19.05	.5	16.81	.5	15.04	.5	13.61
.6	21.93	.6	19.01	.6	16.78	.6	15.02	.6	13.59
.7	21.88	.7	18.98	.7	16.75	.7	14.99	.7	13.57
.8	21.83	.8	18.94	.8	16.72	.8	14.97	.8	13.55
.9	21.79	.9	18.90	.9	16.69	.9	14.95	.9	13.53
46.	21.74	**53.**	18.87	**60.**	16.67	**67.**	14.93	**74.**	13.51
.1	21.69	.1	18.83	.1	16.64	.1	14.90	.1	13.50
.2	21.65	.2	18.80	.2	16.61	.2	14.88	.2	13.48
.3	21.60	.3	18.76	.3	16.58	.3	14.86	.3	13.46
.4	21.55	.4	18.73	.4	16.56	.4	14.84	.4	13.44
.5	21.51	.5	18.69	.5	16.53	.5	14.81	.5	13.42
.6	21.46	.6	18.66	.6	16.50	.6	14.79	.6	13.40
.7	21.41	.7	18.62	.7	16.47	.7	14.77	.7	13.39
.8	21.37	.8	18.59	.8	16.45	.8	14.75	.8	13.37
.9	21.32	.9	18.55	.9	16.42	.9	14.73	.9	13.35
47.	21.28	**54.**	18.52	**61.**	16.39	**68.**	14.71	**75.**	13.33
.1	21.23	.1	18.48	.1	16.37	.1	14.68	.1	13.32
.2	21.19	.2	18.45	.2	16.34	.2	14.66	.2	13.30
.3	21.14	.3	18.42	.3	16.31	.3	14.64	.3	13.28
.4	21.10	.4	18.38	.4	16.29	.4	14.62	.4	13.26
.5	21.05	.5	18.35	.5	16.26	.5	14.60	.5	13.25
.6	21.01	.6	18.32	.6	16.23	.6	14.58	.6	13.23
.7	20.96	.7	18.28	.7	16.21	.7	14.56	.7	13.21
.8	20.92	.8	18.25	.8	16.19	.8	14.53	.8	13.19
.9	20.88	.9	18.21	.9	16.16	.9	14.51	.9	13.18
48.	20.83	**55.**	18.18	**62.**	16.13	**69.**	14.49	**76.**	13.16
.1	20.79	.1	18.15	.1	16.10	.1	14.47	.1	13.14
.2	20.75	.2	18.12	.2	16.08	.2	14.45	.2	13.12
.3	20.70	.3	18.08	.3	16.05	.3	14.43	.3	13.11
.4	20.66	.4	18.05	.4	16.03	.4	14.41	.4	13.09
.5	20.62	.5	18.02	.5	16.00	.5	14.39	.5	13.07
.6	20.57	.6	17.99	.6	15.97	.6	14.37	.6	13.05
.7	20.53	.7	17.95	.7	15.95	.7	14.35	.7	13.04
8	20.49	.8	17.92	.8	15.92	.8	14.33	.8	13.02
.9	20.45	.9	17.89	.9	15.90	.9	14.31	.9	13.00

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains	Number of Yarn.	120yds weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds weigh grains.	Number of Yarn.
77.	12.99	**84.**	11.90	**91.**	10.99	**98.**	10.20	**105.**	9.52
.1	12.97	.1	11.89	.1	10.98	.1	10.19	.1	9.51
.2	12.95	.2	11.88	.2	10.96	.2	10.18	.2	9.51
.3	12.94	.3	11.86	.3	10.95	.3	10.17	.3	9.50
.4	12.92	.4	11.85	.4	10.94	.4	10.16	.4	9.49
.5	12.90	.5	11.83	.5	10.93	.5	10.15	.5	9.48
.6	12.89	.6	11.82	.6	10.92	.6	10.14	.6	9.47
.7	12.87	.7	11.81	.7	10.91	.7	10.13	.7	9.46
.8	12.85	.8	11.79	.8	10.89	.8	10.12	.8	9.45
.9	12.84	.9	11.78	.9	10.88	.9	10.11	.9	9.44
78.	12.82	**85.**	11.76	**92.**	10.87	**99.**	10.10	**106.**	9.43
.1	12.80	.1	11.75	.1	10.86	.1	10.09	.1	9.43
.2	12.79	.2	11.74	.2	10.85	.2	10.08	.2	9.42
.3	12.77	.3	11.72	.3	10.83	.3	10.07	.3	9.41
.4	12.76	.4	11.71	.4	10.82	.4	10.06	.4	9.40
.5	12.74	.5	11.70	.5	10.81	.5	10.05	.5	9.39
.6	12.72	.6	11.68	.6	10.80	.6	10.04	.6	9.38
.7	12.71	.7	11.67	.7	10.79	.7	10.03	.7	9.37
.8	12.69	.8	11.66	.8	10.78	.8	10.02	.8	9.36
.9	12.67	.9	11.64	.9	10.76	.9	10.01	.9	9.35
79.	12.66	**86.**	11.63	**93.**	10.75	**100.**	10.00	**107.**	9.35
.1	12.64	.1	11.61	.1	10:74	.1	9.99	.1	9.34
.2	12.63	.2	11.60	.2	10.73	.2	9.98	.2	9.33
.3	12.61	.3	11.59	.3	10.72	.3	9.97	.3	9.32
.4	12.59	.4	11.57	.4	10.71	.4	9.96	.4	9.31
.5	12.58	.5	11.56	.5	10.70	.5	9.95	.5	9.30
.6	12.56	.6	11.55	.6	10.68	.6	9.94	.6	9.29
.7	12.55	.7	11.53	.7	10.67	.7	9.93	.7	9.29
.8	12.53	.8	11.52	.8	10.66	.8	9.92	.8	9.28
.9	12.52	.9	11.51	.9	10.65	.9	9.91	.9	9.27
80.	12.50	**87.**	11.49	**94.**	10.64	**101.**	9.90	**108.**	9.26
.1	12.48	.1	11.48	.1	10.63	.1	9.89	.1	9.25
.2	12.47	.2	11.47	.2	10.62	.2	9.88	.2	9.24
.3	12.45	.3	11.45	.3	10.60	.3	9.87	.3	9.23
.4	12.44	.4	11.44	.4	10.59	.4	9.86	.4	9.23
.5	12.42	.5	11.43	.5	10.58	.5	9.85	.5	9.22
.6	12.41	.6	11.42	.6	10.57	.6	9.84	.6	9.21
.7	12.39	.7	11.40	.7	10.56	.7	9.83	.7	9.20
.8	12.38	.8	11.39	.8	10.55	.8	9.82	.8	9.19
.9	12.36	.9	11.38	.9	10.54	.9	9.81	.9	9.18
81.	12.35	**88.**	11.36	**95.**	10.53	**102.**	9.80	**109.**	9.17
.1	12.33	.1	11.35	.1	10.52	.1	9.79	.2	9.16
.2	12.32	.2	11.34	.2	10.50	.2	9.78	.4	9.14
.3	12.30	.3	11.33	.3	10.49	.3	9.78	.6	9.12
.4	12.29	.4	11.31	.4	10.48	.4	9.77	.8	9.11
.5	12.27	.5	11.30	.5	10.47	.5	9.76	110.	9.09
.6	12.25	.6	11.29	.6	10.46	.6	9.75	.2	9.07
.7	12.24	.7	11.27	.7	10.45	.7	9.74	.4	9.06
.8	12.22	.8	11.26	.8	10.44	.8	9.73	.6	9.04
.9	12.21	.9	11.25	.9	10.43	.9	9.72	.8	9.03
82.	12.20	**89.**	11.24	**96.**	10.42	**103.**	9.71	**111.**	9.01
.1	12.18	.1	11.22	.1	10.41	.1	9.70	.2	8.99
.2	12.17	.2	11.21	.2	10.40	.2	9.69	.4	8.98
.3	12.15	.3	11.20	.3	10.38	.3	9.68	.6	8.96
.4	12.14	.4	11.19	.4	10.37	.4	9.67	.8	8.94
.5	12.12	.5	11.17	.5	10.36	.5	9.66	112.	8.93
.6	12.11	.6	11.16	.6	10.35	.6	9.65	.2	8.91
.7	12.09	.7	11.15	.7	10.34	.7	9.64	.4	8.90
.8	12.08	.8	11.14	.8	10.33	.8	9.63	.6	8.88
.9	12.06	.9	11.12	.9	10.32	.9	9.62	.8	8.87
83.	12.05	**90.**	11.11	**97.**	10.31	**104.**	9.62	**113.**	8.85
.1	12.03	.1	11.10	.1	10.30	.1	9.61	.2	8.83
.2	12.02	.2	11.09	.2	10.29	.2	9.60	.4	8.82
.3	12.00	.3	11.07	.3	10.28	.3	9.59	.6	8.80
.4	11.99	.4	11.06	.4	10.27	.4	9.58	.8	8.79
.5	11.98	.5	11.05	.5	10.26	.5	9.57	114.	8.77
.6	11.96	.6	11.04	.6	10.25	.6	9.56	.2	8.76
.7	11.95	.7	11.03	.7	10.24	.7	9.55	.4	8.74
.8	11.93	.8	11.01	.8	10.22	.8	9.54	.6	8.73
.9	11.92	.9	11.00	.9	10.21	.9	9.53	.8	8.71

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn	120yds. weigh grains.	Number of Yarn.
115.	8.70	**140.**	7.14	**180.**	5.56	**250.**	4.00	**400.**	2.50
.2	8.68	.5	7.12	181.	5.52	252.	3.97	405.	2.47
.4	8.67	141.	7.09	182.	5.49	254.	3.94	410.	2.44
.6	8.65	.5	7.07	183.	5.46	256.	3.91	415.	2.41
.8	8.64	142.	7.04	184.	5.43	258.	3.88	420.	2.38
116.	8.62	.5	7.02	185.	5.41	260.	3.85	425.	2.35
.2	8.61	143.	6.99	186.	5.38	262.	3.82	430.	2.33
.4	8.59	.5	6.97	187.	5.35	264.	3.79	435.	2.30
.6	8.58	144.	6.94	188.	5.32	266.	3.76	440.	2.27
.8	8.56	.5	6.92	189.	5.29	268.	3.73	445.	2.25
117.	8.55	**145.**	6.90	**190.**	5.26	**270.**	3.70	**450.**	2.22
.2	8.53	.5	6.87	191.	5.24	272.	3.68	455.	2.20
.4	8.52	146.	6.85	192.	5.21	274.	3.65	460.	2.17
.6	8.50	.5	6.83	193.	5.18	276.	3.62	465.	2.15
.8	8.49	147.	6.80	194.	5.15	278.	3.60	470.	2.13
118.	8.47	.5	6.78	195.	5.13	280.	3.57	475.	2.11
.2	8.46	148.	6.76	196.	5.10	282.	3.55	480.	2.08
.4	8.45	.5	6.73	197.	5.08	284.	3.52	485.	2.06
.6	8.43	149.	6.71	198.	5.05	286.	3.50	490.	2.04
.8	8.42	.5	6.69	199.	5.03	288.	3.47	495.	2.02
119.	8.40	**150.**	6.67	**200.**	5.00	**290.**	3.45	**500.**	2.00
.2	8.39	.5	6.64	201.	4.98	292.	3.42	505.	1.98
.4	8.38	151.	6.62	202.	4.95	294.	3.40	510.	1.96
.6	8.36	.5	6.60	203.	4.93	296.	3.38	515.	1.94
.8	8.35	152.	6.58	204.	4.90	298.	3.36	520.	1.92
120.	8.33	.5	6.56	205.	4.88	300.	3.33	525.	1.90
.2	8.32	153.	6.54	206.	4.85	302.	3.31	530.	1.89
.4	8.31	.5	6.51	207.	4.83	304.	3.29	535.	1.87
.6	8.29	154.	6.49	208.	4.81	306.	3.27	540.	1.85
.8	8.28	.5	6.47	209.	4.78	308.	3.25	545.	1.83
121.	8.26	**155.**	6.45	**210.**	4.76	**310.**	3.23	**550.**	1.82
.4	8.24	.5	6.43	211.	4.74	312.	3.21	555.	1.80
.6	8.22	156.	6.41	212.	4.72	314.	3.18	560.	1.79
.8	8.21	.5	6.39	213.	4.69	316.	3.17	565.	1.77
122.	8.20	157.	6.37	214.	4.67	318.	3.14	570.	1.75
.5	8.16	.5	6.35	215.	4.65	320.	3.12	575.	1.74
123.	8.13	158.	6.33	216.	4.63	322.	3.11	580.	1.72
.5	8.10	.5	6.31	217.	4.61	324.	3.09	585.	1.71
124.	8.06	159.	6.29	218.	4.59	326.	3.07	590.	1.69
.5	8.03	.5	6.27	219.	4.57	328.	3.05	595.	1.68
125.	8.00	**160.**	6.25	**220.**	4.55	**330.**	3.03	**600.**	1.67
.5	7.97	.5	6.23	221.	4.52	332.	3.01	610.	1.64
126.	7.94	161.	6.21	222.	4.50	334.	2.99	620.	1.61
.5	7.91	.5	6.19	223.	4.48	336.	2.98	630.	1.59
127.	7.87	162.	6.17	224.	4.46	338.	2.96	640.	1.56
.5	7.84	.5	6.15	225.	4.44	340.	2.94	650.	1.54
128.	7.81	163.	6.13	226.	4.42	342.	2.92	660.	1.52
.5	7.78	.5	6.12	227.	4.41	344.	2.91	670.	1.49
129.	7.75	164.	6.10	228.	4.39	346.	2.89	680.	1.47
.5	7.72	.5	6.08	229.	4.37	348.	2.87	690.	1.45
130.	7.69	**165.**	6.06	**230.**	4.35	**350.**	2.86	**700.**	1.43
.5	7.66	.5	6.04	231.	4.33	352.	2.84	710.	1.41
131.	7.63	166.	6.02	232.	4.31	354.	2.82	720.	1.39
.5	7.60	.5	6.01	233.	4.29	356.	2.81	730.	1.37
132.	7.58	167.	5.99	234.	4.27	358.	2.79	740.	1.35
.5	7.55	.5	5.97	235.	4.26	360.	2.78	750.	1.33
133.	7.52	168.	5.95	236.	4.24	362.	2.76	760.	1.32
.5	7.49	.5	5.93	237.	4.22	364.	2.75	770.	1.30
134.	7.46	169.	5.92	238.	4.20	366.	2.73	780.	1.28
.5	7.43	.5	5.90	239.	4.18	368.	2.72	790.	1.27
135.	7.41	**170.**	5.88	**240.**	4.17	**370.**	2.70	**800.**	1.25
.5	7.38	171.	5.85	241.	4.15	372.	2.69	820.	1.22
136.	7.35	172.	5.81	242.	4.13	374.	2.67	840.	1.19
.5	7.33	173.	5.78	243.	4.12	376.	2.66	860.	1.16
137.	7.30	174.	5.75	244.	4.10	378.	2.65	880.	1.14
.5	7.27	175.	5.71	245.	4.08	380.	2.63	900.	1.11
138.	7.25	176.	5.68	246.	4.07	382.	2.62	925.	1.08
.5	7.22	177.	5.65	247.	4.05	385.	2.60	950.	1.05
139.	7.19	178.	5.62	248.	4.03	390.	2.56	975.	1.03
.5	7.17	179.	5.59	249.	4.02	395.	2.53	1000.	1.00

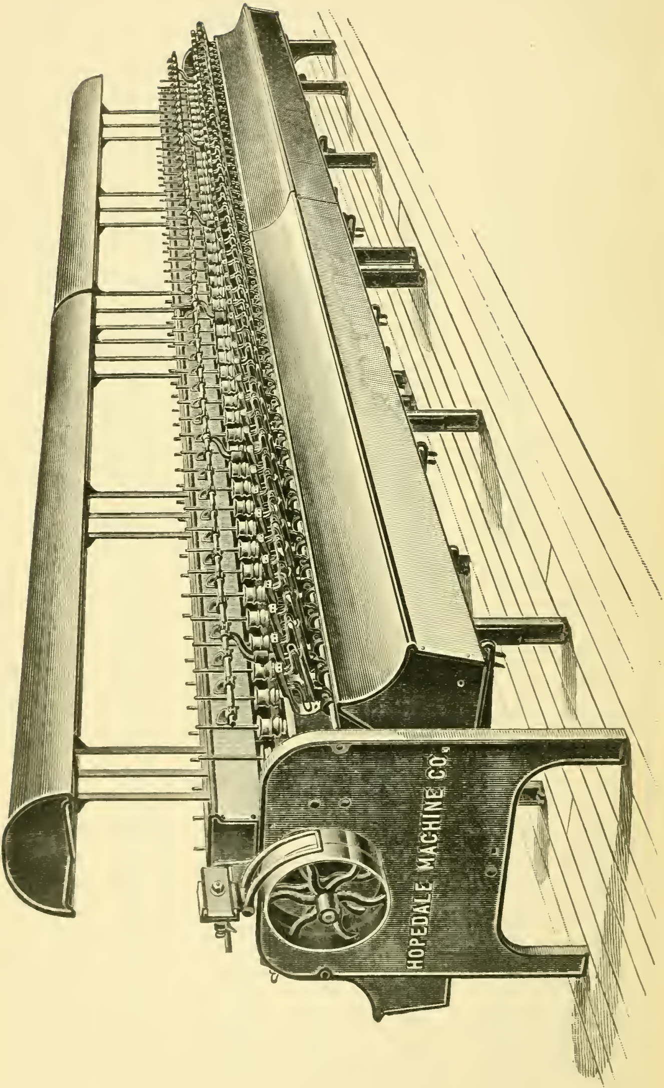
TWIST TABLE,

Showing the square root of the numbers or counts from 1 to 140 hanks in the pound, with the twist per inch for different kinds of yarn.

Counts or Numbers.	Square Root.	Ordinary Warp Twist.	Whitman's Warp Twist.	Extra Mule Warp Twist.	Mule Warp Twist.	Mule Filling Twist.
1	**1.0000**	**4.75**	**4.50**	**4.00**	**3.75**	**3.25**
2	1.4142	6.72	6.36	5.66	5.30	4.60
3	1.7321	8.23	7.79	6.93	6.50	5.63
4	2.0000	9.50	9.00	8.00	7.50	6.50
5	2.2361	10.62	10.06	8.94	8.39	7.27
6	2.4495	11.64	11.02	9.80	9.19	7.96
7	2.6458	12.57	11.91	10.58	9.92	8.60
8	2.8284	13.44	12.73	11.31	10.61	9.19
9	3.0000	14.25	13.50	12.00	11.25	9.75
10	3.1623	15.02	14.23	12.65	11.86	10.28
11	3.3166	15.75	14.92	13.27	12.44	10.78
12	3.4641	16.45	15.59	13.86	12.99	11.26
13	3.6056	17.13	16.22	14.42	13.52	11.72
14	3.7417	17.77	16.84	14.97	14.03	12.16
15	3.8730	18.40	17.43	15.49	14.52	12.59
16	4.0000	19.00	18.00	16.00	15.00	13.00
17	4.1231	19.58	18.55	16.49	15.46	13.40
18	4.2426	20.15	19.09	16.97	15.91	13.79
19	4.3589	20.70	19.62	17.44	16.35	14.17
20	4.4721	21.24	20.12	17.89	16.77	14.53
21	4.5826	21.77	20.62	18.33	17.18	14.89
22	4.6904	22.28	21.11	18.76	17.59	15.24
23	4.7958	22.78	21.58	19.18	17.98	15.59
24	4.8990	23.27	22.05	19.60	18.37	15.92
25	5.0000	23.75	22.50	20.00	18.75	16.25
26	5.0990	24.22	22.95	20.40	19.12	16.57
27	5.1962	24.68	23.38	20.78	19.49	16.89
28	5.2915	25.13	23.81	21.17	19.84	17.20
29	5.3852	25.58	24.23	21.54	20.19	17.50
30	5.4772	26.02	24.65	21.91	20.54	17.80
31	5.5678	26.45	25.05	22.27	20.88	18.10
32	5.6569	26.87	25.46	22.63	21.21	18.38
33	5.7446	27.29	25.85	22.98	21.54	18.67
34	5.8310	27.70	26.24	23.32	21.87	18.95
35	5.9161	28.10	26.62	23.66	22.19	19.23
36	6.0000	28.50	27.00	24.00	22.50	19.50
37	6.0828	28.89	27.37	24.33	22.81	19.77
38	6.1644	29.28	27.74	24.66	23.12	20.03
39	6.2450	29.66	28.10	24.98	23.42	20.30
40	6.3246	30.04	28.46	25.30	23.72	20.55
41	6.4031	30.41	28.81	25.61	24.01	20.81
42	6.4807	30.78	29.16	25.92	24.30	21.06
43	6.5574	31.15	29.51	26.23	24.59	21.31
44	6.6332	31.51	29.85	26.53	24.87	21.56
45	6.7082	31.86	30.19	26.83	25.16	21.80
46	6.7823	32.22	30.52	27.13	25.43	22.04
47	6.8557	32.56	30.85	27.42	25.71	22.28
48	6.9282	32.91	31.18	27.71	25.98	22.52
49	7.0000	33.25	31.50	28.00	26.25	22.75
50	7.0711	33.59	31.82	28.28	26.52	22.98
51	7.1414	33.92	32.14	28.57	26.78	23.21
52	7.2111	34.25	32.45	28.85	27.04	23.44
53	7.2801	34.58	32.76	29.12	27.30	23.66
54	7.3485	34.91	33.07	29.39	27.56	23.88
55	7.4162	35.23	33.37	29.66	27.81	24.10
56	7.4833	35.55	33.67	29.93	28.06	24.32
57	7.5498	35.86	33.97	30.20	28.31	24.54
58	7.6158	36.17	34.27	30.46	28.56	24.75
59	7.6811	36.49	34.57	30.72	28.80	24.96
60	7.7460	36.79	34.86	30.98	29.05	25.17
61	7.8102	37.10	35.15	31.24	29.29	25.38
62	7.8740	37.40	35.43	31.50	29.53	25.59
63	7.9373	37.70	35.72	31.75	29.76	25.80
64	8.0000	38.00	36.00	32.00	30.00	26.00
65	8.0623	38.30	36.28	32.25	30.23	26.20
66	8.1240	38.59	36.56	32.50	30.47	26.40
67	8.1854	38.88	36.83	32.74	30.70	26.60
68	8.2462	39.17	37.11	32.98	30.92	26.80
69	8.3066	39.46	37.38	33.23	31.15	27.00
70	8.3666	39.74	37.65	33.47	31.37	27.19

TWIST TABLE, *Continued.*

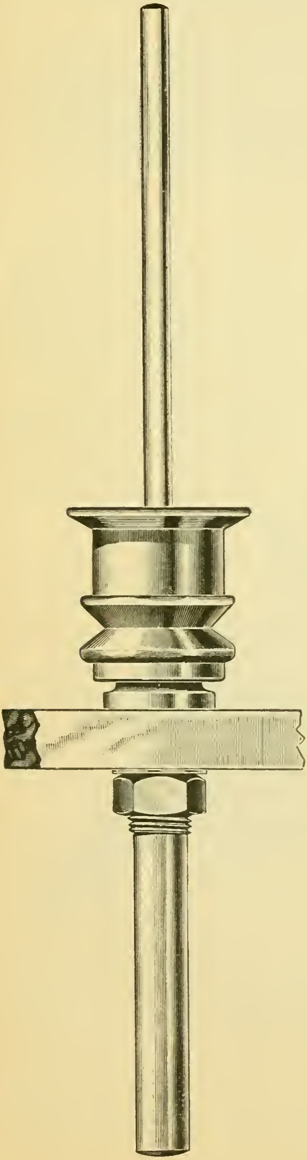
Counts or Numbers.	Square Root.	Ordinary Warp Twist.	Whitman's Warp Twist.	Extra Mule Warp Twist.	Mule Warp Twist.	Mule Filling Twist.
1	**1.0000**	**4.75**	**4.50**	**4.00**	**3.75**	**3.25**
71	8.4261	40.02	37.92	33.70	31.60	27.38
72	8.4853	40.31	38.18	33.94	31.82	27.58
73	8.5440	40.58	38.45	34.18	32.04	27.77
74	8.6023	40.86	38.71	34.41	32.26	27.96
75	8.6603	41.14	38.97	34.64	32.48	28.15
76	8.7178	41.41	39.23	34.87	32.69	28.33
77	8.7750	41.68	39.49	35.10	32.91	28.52
78	8.8318	41.95	39.74	35.33	33.12	28.70
79	8.8882	42.22	40.00	35.55	33.33	28.89
80	8.9443	42.49	40.25	35.78	33.54	29.07
81	9.0000	42.75	40.50	36.00	33.75	29.25
82	9.0554	43.01	40.75	36.22	33.96	29.43
83	9.1104	43.27	41.00	36.44	34.16	29.61
84	9.1652	43.53	41.24	36.66	34.37	29.79
85	9.2195	43.79	41.49	36.88	34.57	29.96
86	9.2736	44.05	41.73	37.09	34.78	30.14
87	9.3274	44.31	41.97	37.31	34.98	30.31
88	9.3808	44.56	42.21	37.52	35.18	30.49
89	9.4340	44.81	42.45	37.74	35.38	30.66
90	9.4868	45.06	42.69	37.95	35.58	30.83
91	9.5394	45.31	42.93	38.16	35.77	31.00
92	9.5917	45.56	43.16	38.37	35.97	31.17
93	9.6437	45.81	43.40	38.57	36.16	31.34
94	9.6954	46.05	43.63	38.78	36.36	31.51
95	9.7468	46.30	43.86	38.99	36.55	31.68
96	9.7980	46.54	44.09	39.19	36.74	31.84
97	9.8489	46.78	44.32	39.40	36.93	32.01
98	9.8995	47.02	44.55	39.60	37.12	32.17
99	9.9499	47.26	44.77	39.80	37.31	32.34
100	10.0000	47.50	45.00	40.00	37.50	32.50
101	10.0499	47.74	45.22	40.20	37.69	32.66
102	10.0995	47.97	45.45	40.40	37.87	32.82
103	10.1489	48.21	45.67	40.60	38.06	32.98
104	10.1980	48.44	45.89	40.79	38.24	33.14
105	10.2470	48.67	46.11	40.99	38.43	33.30
106	10.2956	48.90	46.33	41.18	38.61	33.46
107	10.3441	49.13	46.55	41.38	38.79	33.62
108	10.3973	49.36	46.77	41.57	38.97	33.77
109	10.4403	49.59	46.98	41.76	39.15	33.93
110	10.4881	49.82	47.20	41.95	39.33	34.09
111	10.5357	50.04	47.41	42.14	39.51	34.24
112	10.5830	50.27	47.62	42.33	39.69	34.39
113	10.6301	50.49	47.84	42.52	39.86	34.55
114	10.6771	50.72	48.05	42.71	40.04	34.70
115	10.7238	50.94	48.26	42.90	40.21	34.85
116	10.7703	51.16	48.47	43.08	40.39	35.00
117	10.8167	51.38	48.67	43.27	40.56	35.15
118	10.8628	51.60	48.88	43.45	40.74	35.30
119	10.9087	51.82	49.09	43.63	40.91	35.45
120	10.9545	52.03	49.30	43.82	41.08	35.60
121	11.0000	52.25	49.50	44.00	41.25	35.75
122	11.0454	52.47	49.70	44.18	41.42	35.90
123	11.0905	52.68	49.91	44.36	41.59	36.04
124	11.1355	52.89	50.11	44.54	41.76	36.19
125	11.1803	53.11	50.31	44.72	41.93	36.34
126	11.2250	53.32	50.51	44.90	42.09	36.48
127	11.2694	53.53	50.71	45.08	42.26	36.63
128	11.3137	53.74	50.91	45.25	42.43	36.77
129	11.3578	53.95	51.12	45.43	42.59	36.91
130	11.4018	54.16	51.31	45.61	42.76	37.06
131	11.4455	54.37	51.50	45.78	42.92	37.20
132	11.4891	54.57	51.70	45.96	43.08	37.34
133	11.5326	54.78	51.90	46.13	43.25	37.48
134	11.5758	54.99	52.09	46.30	43.41	37.62
135	11.6190	55.19	52.29	46.48	43.57	37.76
136	11.6619	55.39	52.48	46.65	43.73	37.90
137	11.7047	55.60	52.67	46.82	43.89	38.04
138	11.7473	55.80	52.86	47.99	44.05	38.18
139	11.7898	56.00	53.05	47.16	44.21	38.32
140	11.8322	56.20	53.24	47.33	44.37	38.45


HOPEDALE MACHINE CO.

THE HOPEDALE MACHINE CO. SPOOLER.

THE HOPEDALE SPOOLER.

In the inevitable course of competition, our Spooler is copied so far as lapse of patents will permit. General details and appearance are alike duplicated with a persistency that indirectly pays us a sincere compliment. Our latest Spooler serves to show what an advance is possible in a seemingly limited field, when competition forces higher efficiency.



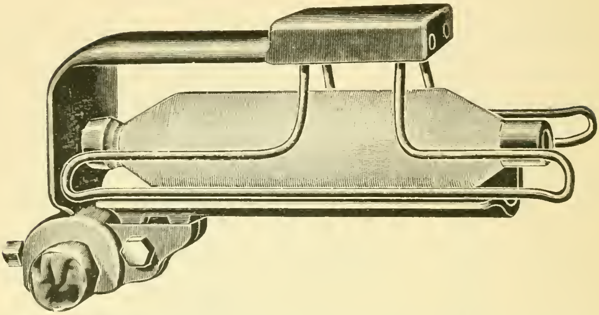
We call attention to the following improvements:

- Single Rail Spindle,
- New Features in Bobbin Holders,
- Improved Spooler Guides,
- Sheet Steel Boxes,
- Adjustable Height,
- Spool Raising Device,
- New System of Bobbin Chutes,
- New Design of Frame.

Single Rail Spooler Spindles are now almost universally demanded. The advantage lies in their superior convenience. The old two-rail spindle requires frequent oiling, is difficult to remove, and is liable to be cramped in its bearings as the rails may get out of level. Our single-rail spindle has several very neat features. The retaining device is out of sight, and needs no tool to operate it. No one doubts our capacity to make good spindles.

(The cut shows the general form. Also made with Woodmancy oil tube.)

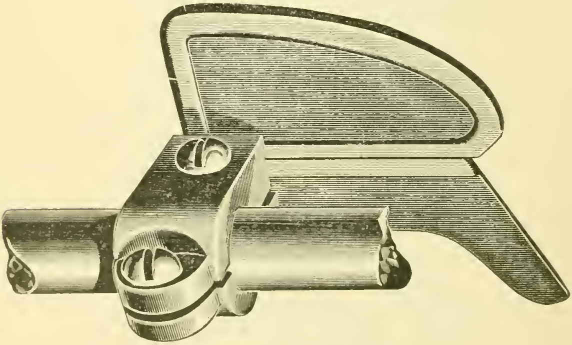
OUR BOBBIN HOLDERS



Have the simplest and best construction, which can only be used by other builders when we supply them. We have a new pattern holder especially designed for use with bobbins spun in large rings. We make special holders for special bobbins, and can furnish anything desired in this line.

Our cut shows the improved Wade Holder. For large bobbins we also have another pattern known as the "Bourne," which gives excellent satisfaction. The name is derived from Mr. Bourne of the Stark Mills, who developed this type after long experiment with practical conditions.

OUR SPOOLER GUIDES



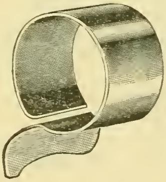
Have been improved in design, the principle of operation remaining the same. The Northrop Guide is well known and needs little comment. We do not believe in doing Carding at the Spooler, but those who do will find this Guide easy to adjust to the required closeness.

We are also experimenting with other forms of guide for use on special work, and will advertise them when results will warrant it.

OUR NEXT IMPROVEMENT

Is certainly radical, and is bound to commend itself. We have introduced steel side boxes, spool boxes and top creels, in the place of the former wooden articles. They are neat, clean and indestructible. Wooden parts invariably split, sliver and wear, especially under the hard usage given on a spooler. We are confident this improvement need only be seen to be demanded.

Our Mr. Rhoades has applied a very novel idea to a spooler, by which all sorting and selection of bobbins is done away with. A series of chutes are placed back of the bobbin boxes which lead to small removable boxes placed on the floor under the bobbin boxes. The spooler tender has nothing but full bobbins in the bobbin boxes, as the empty bobbins are all dropped down the chutes, ready to be returned to the doffers. This is not shown in the cut of our regular spooler, as it is an extra only applied when ordered. We believe it well worth the extra cost, and far preferable to the traveling belt which some mills use for the same purpose.

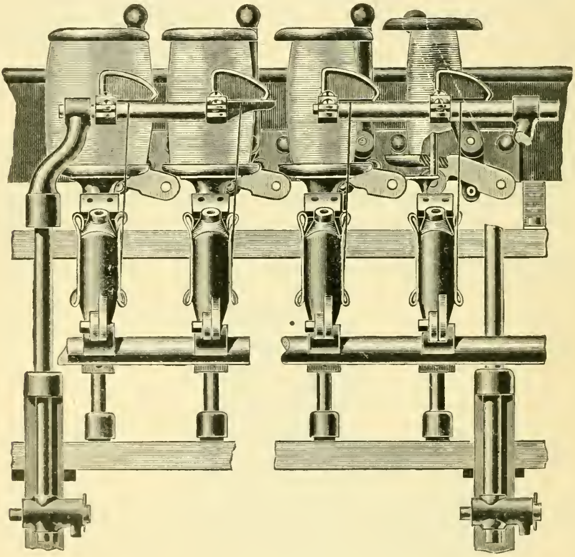


THE BOURNE AND JOHNSON SPOOLER TENDER'S KNOT TRIMMER.

As shown in the cut, this device consists in a short knife blade made part of a ring which is worn on the little finger of the right hand. After tying the usual spoolers' knot, the operative cuts the ends off by a simple motion, easily learned in practice, and much quicker and more satisfactory than breaking the ends with the fingers.

The knot question has become very important in the weaving-room, as it has been proved that three-quarters of the warp breaks at the loom come from either large knots, or knots with long ends. This device, which was developed at the Stark Mills, is very effective in preventing the long ends. It does not, however, help the problem of a large knot, as that can only be solved by tying a different kind of a knot. A spooler's knot, by actual measurement, is considerably larger than a weaver's knot, and much more liable to cause breakage in the loom. A weaver's knot, if tied at the spooler, would overcome the difficulties so far as would seem possible with present knowledge. A weaver's knot is smaller than any other method of securely uniting two ends of yarn, and, from the manner of tying, it cannot have long ends.

The objection to it at the spooler has been that it took more time for the spooler tenders to tie it. We have met this objection by an ingenious attachment to our spooler, known as



THE SPOOL RAISING DEVICE.

This attachment allows the spooler tender to stop the spool by simple pressure of the lever which projects above each one, so that both hands can be free to tie the knot. The operative ordinarily has to hold the spool from turning with the left hand, but both hands should be unhampered in tying a weaver's knot with rapidity.

General Draper found while in England, recently, that spooler tenders are compelled to tie weavers' knots on all numbers of yarn. There are also mills in this country where weavers' knots are enforced, and the results amply prove the benefit.

While our arguments might tend to discussion between two of our own productions, we believe that either method is preferable to present practice. The knot trimmer will help the matter without causing the operatives to learn new methods, while the weavers' knots will secure perfection at the expense of slight delay and trouble in getting the help used to the change. There is chance for great improvement in warps, and far-seeing men are beginning to appreciate the evils of the present situation.

We owe much of our knowledge on the knot question to Mr. A. F. Knight of the Amory Mfg. Co., who has studied the matter thoroughly and was, we believe, the first man to investigate the question by practical tests in the weaving-room.

It will be noticed in our cut, that our frame is of a new design. We have arranged details for extra convenience, and have studied to produce a machine of special advantage for cleanliness. Fancy patterns and dirt catching prejections are avoided as far as possible. With our single-rail we use a metal plate extending the full length of the spooler, which makes it stiff and rigid far beyond the necessities. Another new feature is our adjustable stand and end. We find that in certain sections full grown help are used, while in other localities small help can be had. Our spooler is now made adjustable in height to meet any requirement, and fit the machine to the user.

We have lately changed our traverse motion by compounding the rocker arm in such a way as to prevent any damage in case a spool falls and gets under the descending guide rod. This is a small point, but competitors pointed out the former defect as a serious fault when condemning our machines. As it was the only point we ever heard criticized, they must now admit that we have reached perfection.

Before buying Spoolers of other parties, it would be well to consider the following facts:

Spoolers are a distinct specialty with us, and not a minor consideration.

We have introduced all the important improvements in modern Spoolers.

With our reputation behind them, customers can be assured that our Spoolers will run well, wear well, and cannot be beaten by any machine of the same class at the time they are sold.

The latest improvements cannot be had on competing machines.

Our prices are the lowest, considering the value we give. Be sure and give us a chance to figure on your next order.

SPECIFICATIONS FOR ORDERING SPOOLERS.

How many Spoolers?

How many Spindles in each?

Common, Sawyer or Single Rail Spindle?

What length traverse?

What gauge?

Wade or Bourne bobbin holder, or side spindles?

Will you have Northrop Guide?

Specify number of yarn to be spooled?

Will you have bobbin chutes? (15 cents per spindle extra.)

Will you have spool raising device? (25 cents per spindle extra.)

Will you have top creel?

Will you have top creel and boxes made of steel or wood?

How belted, from above or below?

Will you have 9, 10, 11 or 12 inch pully, face 2 inches?

Shall machines be crated, shod or taken down and boxed?

By what lines do you wish us to make shipment?

Send bobbin full of yarn and sample spool?

Give size of spinning ring used?

Send exact diameter of top of upright spindle?

Blank specification sent on application.

In sending Spool and Bobbin, please specify on same where from.

SPECIFICATIONS FOR NORTHROP SPOOLER GUIDES.

ORDERED

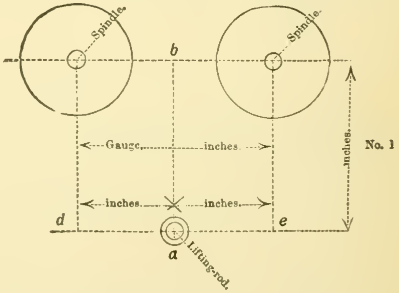
of the

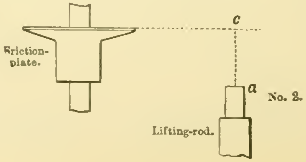
HOPEDALE

MACHINE

COMPANY,

HOPEDALE, MASS.





Answer the following questions:

Give number of spoolers?

Number of spindles in each?

Builder of spooler?

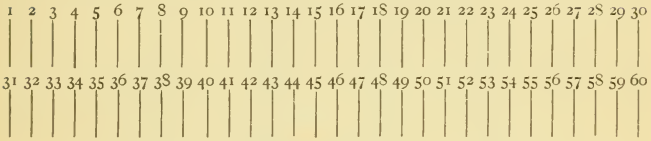
Are lifting rods in the spindle rail?

Are lifting rods in front of the spindle rail?

Are lifting rods behind the spindle rail?

Give total length between end spindles? ....ft........in.

Mark X between spindles where lifting rods come.



If they come opposite spindles put X on the spindle line.

Distance between centres of adjacent spindles, that is, the guage?

Distance A to B—diagram No. 1?

Distance A to C—diagram No. 2—when lifting rod is at the lowest point of traverse?

Distance D to A on diagram No. 1?

Distance A to E on diagram No. 1?

Distance from TOP of lifting rod at LOWEST point of traverse to TOP of UPPER bearing which rod runs through?

Distance from BOTTOM of lifting rod at HIGHEST point of traverse to BOTTOM of LOWER bearing which rod runs through?

Size and shape of top three inches of lifting rod. See diagram No. 2.

DIMENSIONS OF SPOOLERS.

Guage.	3½	3¾	4	4¼	4½	4¾	5	5¼	5½	5¾	6	6½
Diam. head of Spool	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼	5¾
No. of spindles.	Lengths in feet and inches.											
60	10 3	10 11	11 6	12 1	12 8	13 4	13 11	14 6	15 1	15 9	16 4	17 6
80	13 2	14 0	14 10	15 8	16 5	17 3	18 1	18 11	19 8	20 6	21 4	22 11
100	16 1	17 2	18 2	19 2	20 2	21 3	22 3	23 3	24 3	25 4		
120		20 3	21 6	22 9	23 11	25 2	26 5	27 8				
150				28 0	29 7							

Width, including bobbin boxes, four feet.
Weight, from thirty to forty pounds per spindle complete.

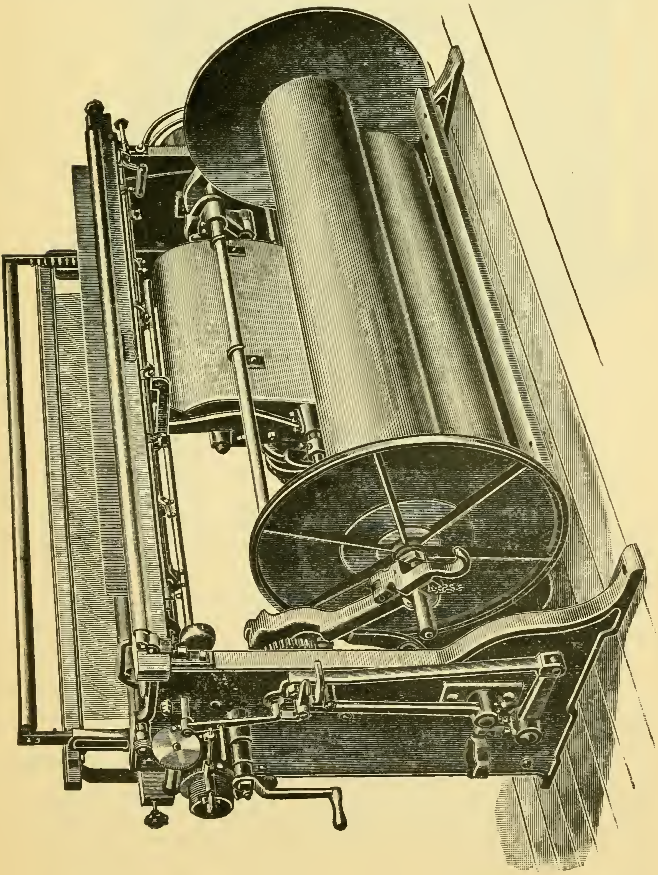
PRODUCTION OF SPOOLERS.

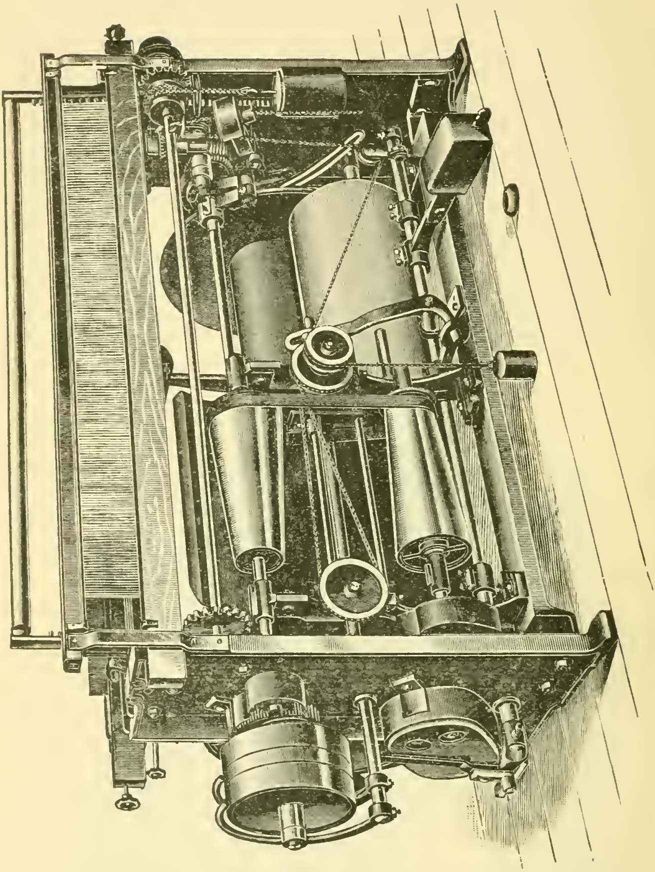
Dimensions of Spool.		Number of Yarn.	Revolutions per minute of the			Number of Rabbeth spindles to 1 spooler spindle, running at 825 revolutions per minute.
Length between heads.	Diam. of heads.		Cylinder, 200. Spindle, 750.	Cylinder, 220. Spindle, 825.	Cylinder, 240. Spindle, 900.	
			Pounds per spindle per week.			
6	5	8	64.3	70.7	77.1	12
		10	51.4	56.6	61.7	
		12	42.9	47.1	51.4	
		14	36.7	40.4	44.1	13
		16	32.1	35.3	38.6	
5	4	18	28.6	31.4	34.3	
		20	25.7	28.3	30.9	14
		22	23.4	25.7	28.1	
		24	21.4	23.6	25.7	
		26	19.8	21.8	23.7	15
		28	18.4	20.2	22.0	
		29	17.7	19.5	21.3	
		30	17.1	18.9	20.6	16
		32	16.1	17.7	19.3	
		34	15.1	16.6	18.1	
4½	3½	36	14.3	15.7	17.1	17
		38	13.5	14.9	16.2	
		40	12.9	14.1	15.4	18
		44	11.7	12.9	14.0	19
		50	10.3	11.3	12.3	20
3½	3¼	60	8.6	9.4	10.3	21
		70	7.3	8.1	8.8	23
		80	6.4	7.1	7.8	25

With the introduction of large bobbins it will be well to experiment with speeds very carefully. The yarn should not be strained by high speed even if the product is less. The tendency of modern mill management is toward favoring the weaving end at possible expense in other departments. Slow speeds at the spooler, warper and slasher all tend toward stronger, more elastic yarn, and less knots in the warp. Better warp tends to increase production at the loom and make better goods. We strongly advise against narrow economy as regards number of spooler spindles. Our spoolers will run as fast as any other, but that is not the question. We recommend the lowest speed table given above, with plenty of spooler spindles to do the work.

THE HOPEDALE SLASHER WARPER.

We sell three-quarters or more of all the Warpers used in this country. It is impossible to control human nature absolutely on any one view, even if it is absolutely sound. That is the reason why we do not sell all the Warpers. We have added improvements in late years that place our machine beyond the reach of competition. We could not conscientiously advise a mill to put in any competing machine were it made a free gift. We can sell an old obsolete warper ourselves at a low price should any one want it. We don't like to see such structures leaving our works, however. When our patents on the late ideas have expired, they will immediately be followed





by our competitors, and their virtues admitted for the first time. The patent term of seventeen years marks the distance at which we keep competition.

We make warpers a distinct specialty. Our machine is always the standard. In its present form it contains many valuable improvements.

A warper contains the generic idea of winding a beam of yarn from a creel full of spools. Starting with the creel, it is necessary to have one so arranged that a large number of spools may be held in a convenient form for piecing up, without the sacrifice of too much floor space. The spools run on skewers which revolve in steps or bearings made of wood, iron or glass. Our glass step is a patented novelty, and easily ahead of any other.

The yarns from the spools pass to the warper, and are first led through a separating comb. They then pass over and under slack rolls and measuring drum through a series of stop motions, and then through a reed to the revolving beam.

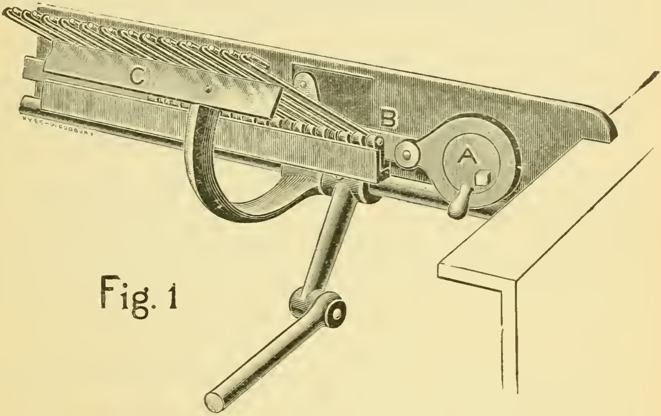


Fig. 1

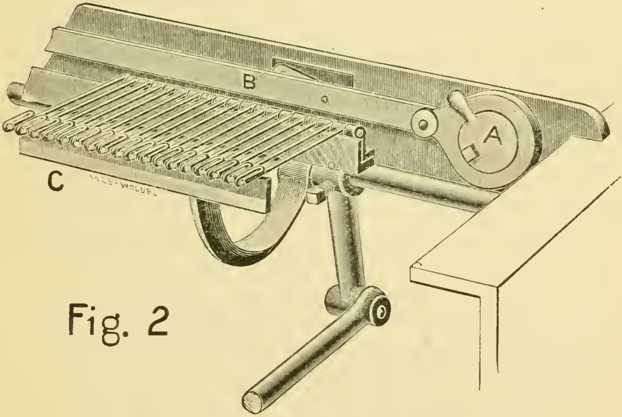


Fig. 2

Improved Walmsley Stop Motion.

The principle of the Walmsley stop motion is familiar to all mill men. It is not necessary therefore to describe it.

Our improvement consists in the use of a locking bar B controlled by an eccentric A. Figure 1 shows the bar in position, and Figure 2 shows it raised for the purpose of freeing the drops.

The stop motion is a most important feature of a warper. The Walmsley is undoubtedly the best in use, as it has been the standard for over twenty years. In its improved form as shown in the cuts, a set of wires can be removed at any point. This helps in changing ends and also in case of accident to drops.

Our measuring roll is accurate and positive, stopping the machine automatically when the beam has wound the required length of yarn.

When the driving drum stops through the action of the stop motion the spools revolve slightly through their inertia, and make a slackness between the spools and the beam. This is taken up by drop or rise rolls. Our rise roll is the most satisfactory device of the kind. It is now made with a positively geared parallel motion by which the roll is always horizontal. A rise roll is always preferable to a drop roll, as it keeps the yarn up out of possible lint and dirt accumulations, saves one knot in piecing up, and is much handier for the operative.

THE CONE DRIVE.

We now mention the most important feature of modern warping, namely, the "Cone Drive."

Mr. Nehemiah Hicks, formerly of Wilkinsonville, was troubled by want of increased production in his warping room. There was no extra room, and his warpers were running as fast as was feasible. On studying the question he perceived that the speed was limited by the tension of the yarn when nearly wound off. On the large spool the speed could easily be increased. Variable speed was necessary therefore, and Mr. Hicks had cones made and applied, increasing his product fifty per cent. while the warpers were running. We saw the value of the idea and purchased the invention, modifying the mechanism to suit general requirements.

The Cone Warper was introduced on the market in the fall of 1891. It has therefore been on sale for four years. Two of these years have not been good business years, as all know, so the number of warpers sold is naturally less than average. We have, however, sold and obtained orders for 670 machines up to November, '95. 304 of these warpers were on original orders and 366 on repeat orders. We know of nothing that can testify to the merit of a machine so well as a second order sent in after trial. The fact that more cone warpers have been sold on repeat orders than on original orders would seem to be very convincing, supposing our mills to be managed by competent supervisors. Some mills have gone so far as to place four and five consecutive orders. To show some of the large representative concerns, we will mention the Berkshire, first order five, second order 18; the Grosvenor-Dale Co.; first order two, other orders 16; the Massachusetts Cotton Mills, first order two, other orders 16; the Ponemah Mills, first order one, second order 30; the Social Manufacturing Co., where the device was originally tested, have ordered 18 in all; the Wamsutta Mills, first order six, other orders 26.

We have no hesitation, whatever, in emphatically recommending this idea. While we do not advise using it to the full extent of its possibilities, it can easily be counted on to increase speed twenty-five per cent. By referring to the back view of the warper it will be seen how the cones are applied. The belt shifts automatically during the winding of the beam, and returns automatically when a new beam is put on.

To appreciate what the Cone Drive accomplishes, it is necessary to study the facts.

The usual spool has a barrel two inches in diameter. Its diameter when full is four inches or more. The spool would, therefore, on the ordinary warper, turn twice as fast when nearly empty as when full.

With the Hicks Cone Drive, the spool would turn as fast at the full spool as at the empty spool. The speed of delivery would be a mean between the two extremes, or would average the speed of delivery when half the spool was unwound. At this point the spool would be three inches in diameter, or 50 per cent. greater than the diameter of the empty spool.

A Warper run with a Hicks Cone attached could therefore produce 50 per cent. more, without increasing the strain on the yarn, if run continuously. As a warper is stopped about a third of the time for tying in, etc., the actual gain in time would be 50 per cent. of 66, or 33 per cent.

That is, 3 Cone Warpers will do the work of 4 Common Warpers.

We, however, think it preferable to use the Cone Warper to improve the quality of the yarn, rather than turn all its advantages to the increase of production. A ratio of 4 Cone Warpers to replace 5 common, enables the merit to be divided and gains both by stronger yarn and more product per machine. In this way the first cost is no more than when buying common warpers, and the product is improved as well as cheapened.

The advantage of using less machines to do the same amount of work is apparent. A warper takes up with its creel a large amount of floor space, which has to be heated, lighted, insured and taxed. Extra supplies, repairs and attendance, also amount to considerable in the long run. There is no question then as to economy.

We cannot conveniently attach the Cone to old warpers. Any manufacturers however having warpers of old patterns would do well to consider throwing them out and replacing them with our latest machines. We have so many improvements that we think there is no question as to the proper policy. We will make a liberal allowance for old machines.

THE BEAM DOFFER.

Another device that has met with universal commendation is our Beam Doffer. It is well known that the hardest physical work in a cotton mill falls on the men handling the beams. This task is straining, wasteful, and uneconomical. To properly take a full beam from a warper requires the services of two strong men. Delays and waste of time are not infrequent in changing beams from the necessity of two hands being called on, and their time is an important element of expense.

Our Beam Doffer is a simple and efficient device by which a female warper tender or boy can easily doff a beam, and fully control it until deposited upon the truck.

Fig. 1 shows the appliance as in position for running, with an empty beam on.

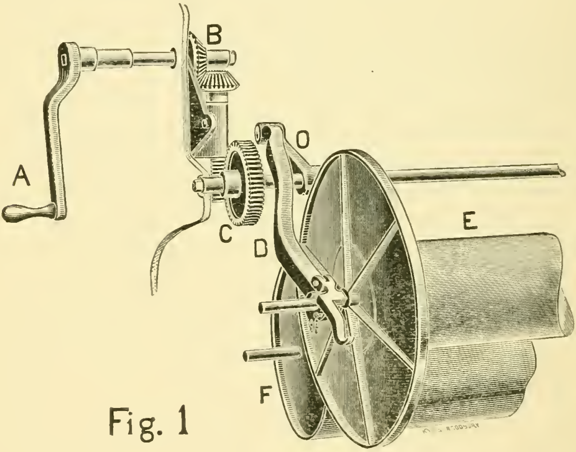


Fig. 1

The crank arms are made in two parts, D, O, jointed so that they fold up while the beam is running, and lengthen while delivering it to the truck. The motion is controlled through the gearing at C, B, and the handle A, so proportioned that the power required is very slight, being about one thirtieth that necessary to balance the dead load. This needs no extended explanation, as its mode of operation must be plain to all.

It is as indispensable as a derrick in a quarry.

Still another vital necessity is our latest inovation,

THE LOW CYLINDER WITH ECCENTRIC DRIVE.

This device is of great practical value, and is shown in the full cuts of our Warpers. A small cylinder or driving drum is used, and by having its driving shaft eccentric to the main shaft, the head of the beam can overlap the centre, and a full size 26 inch beam head can be driven by a 12 inch cylinder. The advantages derived are as follows: We can make the machine 4 inches lower, and the width over all will be 4 1-2 inches narrower. The warper tender can therefore tie in broken ends with far greater ease, and shorter help can be used to tend the machine.

The simplicity of this device is one of its best features. We never yet heard an unfavorable criticism regarding it.

Our slow Motion has been greatly simplified in recent years. It is necessary to start a warper at a reduced speed in order to prevent a sudden strain on the yarn.

Our creels and beams are unexcelled for workmanship. They are good standard productions and we never try to make a profit out of poor workmanship or cheap stock. There is a reputation behind our products.

As all our new features are amply covered by patents, we have no competition in our new improvements. No other parties can furnish you with a Cone Drive, a Beam Doffer, a Small Cylinder, or any other of the modern features. They can only supply the old warper with all its disadvantages.

To compete in price with such machinery, we will build our warper without the more important new features, and yet still put on the Geared Rise Roll, the new Walmsley Stop Motion, the new Slow Motion and the regular reeds, combs and measuring roll. Anyone, therefore, can have a much better machine than any in competition at equal prices. By paying us a fair profit on the more expensive novelties, however, the complete new Warper can be had, which will pay most handsome interest on the extra cost.

It is but natural to expect that new mills will take the latest and best devices. We are not content, however, with this trade, but wish to appeal to old mills with the following arguments:—

Warpers form a very small part of the plant. All the warp yarn, however, passes through them and they take up considerable floor space. We will take these old warpers at a liberal price in trade for new ones, and can furnish a warper plant that requires less machines, less attendance, less floor space, will relieve the yarn of a harmful strain and can be run at less expense.

It would pay a mill having new warpers of the old style, to sell them for old junk and equip with our latest machine. Invention enlarges the scrap heap, but progress is the order of the day.

Machinery is often sold on our reputation by being represented to be "Just as good as Draper's." We recognize the indirect compliment, but discredit the authority behind the assertion.

REEDS AND COMBS.

Our improved Expansion Warper Comb gives the best satisfaction to all who use it. We have often furnished them for other makes of warper.

A maximum number of ends in a 54-inch comb can be reduced 20 per cent. by the expansion apparatus. The Reed is formed by attaching a bar over the top of the wires of a comb, and expands or contracts to the same extent.

SPECIFICATIONS FOR REEDS AND COMBS.

We make three varieties of Warper Reeds or Combs.

1st. The front comb, or comb next the beam. This is open on top.

2d. The back comb. This is similar to the front comb, but has in addition a bar placed about 3 inches behind it to hold the ends from the upper half of the creel down between the wires.

3d. The back reed, which has a top-rail directly over, and covering the tops of the wires.

Directions for Ordering.

No. front combs.	Highest No. ends.	Length Cyl.
No. back combs.	Highest No. ends.	Length Cyl.
No. back reeds.	Highest No. ends.	Length Cyl.

Our usual length of box for either reeds or combs, is 71 inches; if any other length is wanted, please specify.

REMARKS.

Do you have a carrier roll between front comb and beam?

Do you have a carrier roll between back reed or comb and the rising or falling roll?

SPECIFICATION FOR SLASHER WARPERS.

How many Warpers with driving pulleys on Right hand?
How many Warpers with driving pulleys on Left hand?
Large or small cylinder?
(Small cylinder is best and takes larger beams than the large cylinder machine.) (Cannot have Drop roll with small cylinder.)
Rise or Drop roll machine ?
What length of Cylinder ? (Our usual length is 54 inches.)

Shall your Beam Heads be 18, 20, 21, 22, 23, 24, or 26 inches in diameter ?
Diameter of barrel of Beams ?
Largest number of Threads on Section Beam ?
How many Raps, of 3000 yards each, on Beam?
Will you drive the Beam with Threads over it or under?
Do you belt from above or below ?
How many Section Beams ?
How many V Creels?
What height is your room, floor to ceiling?
Will you have spool Bearings cut in the Standard ?
Will you have iron or glass Creel Steps?
Send Sample Spool, also skewer, if used.
By what lines do you wish us to make shipment ?
Do you want the Hicks Cone Drive ?
Do you want the Beam Doffer ?
Do yon want a special Clock ?

You cannot have the Beam Doffer with the Balling Motion.

In sending Samples, please specify where from.

Extra Specification when Balling Motion is desired.
Do you want to wind balls ?
What traverse for Balling Motion? (Regular size is 30 inches.)
Do you want Leasing Motion ?
Blank specification will be sent on application.

Our warper complete weighs about 1,000 pounds, and creels weigh about one pound per spool.

DIMENSIONS OF WARPERS AND CREELS.

The usual length of a warper cylinder is 54 inches. One of the Hopedale warpers with regular 54-inch cylinder occupies a space 7 feet by 3 feet 6 inches with large cylinder and 7 feet by 3 feet 1½ inches small cylinder. A V creel for 400 spools occupies 8 feet by 8 feet, and with the warper a space about 8 feet by 13 feet is required. The driving pulleys are 10 inches in diameter and 2 inches face and require a pulley on driving countershaft of 6 inches face in order to cover loose and slow-motion pulleys on warper.

Our beams are 54 inches between heads, with 9-inch barrel. For yarns up to 12's we recommend a beam with 26-inch heads; from 12's to 30's, 24-inch heads; 30's to 40's, 22-inch heads; and for numbers finer than 40's, 21-inch heads.

The following tabular statements will be found very nearly correct, and handy for reference in this connection.

Weight of yarn on a spool with barrel 1½ inches in diameter:—

With	5-inch head,	6-inch traverse,	1.9 lbs.
"	5 "	" 5 "	" 1.6 "
"	4 "	" 5 "	" 1.0 "
"	3½ "	" 4½ "	" 0.7 "

Weight of yarn on a beam, 54 inches between heads, and with a 9-inch barrel:—

With	26-inch heads,	420 lbs.
"	24 " "	350 "
"	22 " "	285 "
"	21 " "	255 "

IMPROVED CUT-MARKERS FOR SLASHERS.

Positive and Reliable.

The Rolfe Cut-Marker has been in use a number of years, and has given good satisfaction. Its motion is positively obtained by gearing, without wire or springs. It does not waste or splash the marking ink, and is liked by all who use it. It marks the wet yarn between the size box and drying cylinder; the mark is therefore dried in with the sizing, and can neither be rubbed off or transferred to other layers of yarn on the beam. The mark is neat and well defined, and cannot be used as an excuse for making short cuts.

Send for prices.

A larger number of slashers in this country have our cut-markers attached than have those of any other kind.

The following tables show the number of pounds warped on a Hopedale Slasher Warper, per week of sixty hours, at different speeds of cylinder and for different numbers of ends and sizes of yarn. In these tables the actual amount warped is assumed to be two thirds of the theoretical amount. In figuring for a Cone Warper, take the average speed of cylinder from empty to full beam.

WARPER TABLES.

I. REVOLUTIONS PER MINUTE OF CYLINDER, 30; PULLEYS, 163.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	4,179	4,821	5,143	5,465	5,786	6,107	6,589	7,071
10	3,343	3,857	4,114	4,372	4,629	4,886	5,271	5,657
12	2,786	3,214	3,429	3,643	3,857	4,071	4,393	4,714
14	2,388	2,755	2,939	3,123	3,306	3,490	3,765	4,041
16	2,089	2,411	2,571	2,733	2,893	3,053	3,295	3,535
18	1,857	2,143	2,285	2,429	2,571	2,714	2,929	3,143
20	1,671	1,928	2,055	2,186	2,314	2,443	2,636	2,829
22	1,519	1,753	1,870	1,987	2,104	2,221	2,396	2,571
24	1,393	1,607	1,714	1,821	1,929	2,036	2,197	2,357
26	1,286	1,483	1,582	1,681	1,780	1,879	2,027	2,176
28	1,194	1,377	1,469	1,561	1,653	1,745	1,883	2,021
29	1,152	1,330	1,418	1,507	1,596	1,685	1,818	1,950
30	1,114	1,285	1,371	1,457	1,543	1,629	1,757	1,885
32	1,044	1,205	1,285	1,346	1,447	1,527	1,647	1,768
34	983	1,135	1,210	1,286	1,361	1,437	1,551	1,664
36	929	1,071	1,143	1,214	1,286	1,357	1,464	1,571
38	880	1,015	1,083	1,150	1,218	1,285	1,387	1,489
40	836	964	1,029	1,093	1,157	1,221	1,318	1,414
44	760	877	935	993	1,051	1,110	1,198	1,286
50	669	771	823	874	926	977	1,054	1,131

II. REVOLUTIONS PER MINUTE OF CYLINDER, 33; PULLEYS, 180.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	4,597	5.303	5,657	6,011	6,365	6,718	7,248	7,773
10	3,677	4,243	4,525	4,809	5,091	5,375	5,799	6,223
12	3,065	3,535	3,771	4,007	4,243	4,479	4,832	5,185
14	2,627	3,030	3,233	3,435	3,637	3,839	4,142	4,445
16	2,298	2,652	2,829	3,006	3,182	3,359	3,624	3,889
18	2,043	2,357	2,514	2,671	2,829	2,985	3,221	3,457
20	1,839	2,121	2,263	2,405	2,546	2,687	2,899	3,111
22	1,671	1,929	2,057	2,186	2,315	2.443	2,635	2,829
24	1,532	1,768	1,885	2,003	2,121	2,239	2,416	2,587
26	1,415	1,631	1,740	1,849	1,958	2,067	2,230	2,393
28	1,313	1,515	1,616	1,717	1,818	1,919	2,070	2,223
29	1,268	1,463	1,560	1,658	1,755	1,853	2,000	2,146
30	1,225	1,414	1,509	1,603	1,697	1,791	1,933	2,074
32	1,149	1,326	1,414	1,503	1,591	1,679	1,812	1,945
34	1,081	1,248	1,331	1,415	1,497	1,581	1,706	1,831
36	1,021	1,179	1,257	1,335	1,415	1,493	1,611	1,729
38	968	1,117	1,191	1,265	1,340	1,414	1,526	1,637
40	919	1,061	1,131	1,202	1,273	1,343	1,450	1,555
44	836	964	1,029	1,093	1,157	1,221	1,318	1,415
50	735	849	905	961	1,019	1,075	1,159	1,245

WARPER TABLES. — *Continued.*

III. REVOLUTIONS PER MINUTE OF CYLINDER, 36; PULLEYS, 196.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	5,015	5,785	6,171	6,557	6,943	7,329	7,907	8,485
10	4,011	4,629	4,937	5,246	5,555	5,863	6,325	6,789
12	3,343	3,857	4,181	4,372	4,629	4,885	5,271	5,657
14	2,865	3,305	3,527	3,747	3,967	4,188	4,519	4,849
16	2,507	2,893	3,085	3,279	3,471	3,664	3,953	4,243
18	2,229	2,571	2,743	2,915	3,085	3,257	3,515	3,771
20	2,005	2,315	2,468	2,623	2,777	2,931	3,163	3,395
22	1,823	2,104	2,244	2,385	2,525	2,665	2,875	3,085
24	1,671	1,925	2,057	2,185	2,315	2,443	2,636	2,829
26	1,543	1,780	1,899	2,017	2,136	2,255	2,433	2,611
28	1,433	1,653	1,763	1,873	1,983	2,094	2,259	2,425
29	1,383	1,596	1,703	1,809	1,915	2,021	2,181	2,341
30	1,337	1,543	1,645	1,749	1,851	1,955	2,109	2,263
32	1,253	1,447	1,543	1,639	1,736	1,832	1,977	2,121
34	1,180	1,361	1,452	1,543	1,633	1,725	1,861	1,997
36	1,115	1,285	1,371	1,457	1,543	1,629	1,757	1,885
38	1,056	1,219	1,299	1,380	1,461	1,543	1,665	1,787
40	1,003	1,157	1,235	1,311	1,389	1,465	1,581	1,697
44	912	1,052	1,123	1,192	1,262	1,332	1,437	1,543
50	806	925	987	1,049	1,111	1,171	1,265	1,357

IV. REVOLUTIONS PER MINUTE OF CYLINDER, 40; PULLEYS, 218.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	5,571	6,428	6,857	7,286	7,715	8,143	8,785	9,428
10	4,457	5,142	5,485	5,828	6,171	6,515	7,028	7,543
12	3,715	4,285	4,571	4,857	5,143	5,428	5,857	6,285
14	3,184	3,673	3,918	4,163	4,408	4,653	5,020	5.387
16	2,785	3,214	3,428	3,643	3,857	4,071	4,393	4,713
18	2,476	2,857	3,047	3,238	3,428	3,619	3,905	4,190
20	2,228	2,571	2,742	2,915	3,086	3,257	3,515	3,771
22	2,025	2,337	2,493	2,649	2,805	2,961	3,195	3,428
24	1,857	2,143	2,285	2,428	2,571	2,715	2,929	3,143
26	1,715	1,977	2,109	2,241	2,373	2,505	2,703	2,901
28	1,592	1,836	1,959	2,081	2,203	2,326	2,510	2,694
29	1,537	1,773	1,891	2,009	2,128	2,246	2,424	2,600
30	1,485	1,713	1,828	1,943	2,057	2,171	2,343	2,513
32	1,393	1,607	1,713	1,821	1,929	2,035	2,196	2,357
34	1,311	1,513	1,613	1,715	1,815	1,916	2,067	2,219
36	1,238	1,428	1,523	1,619	1,714	1,809	1,952	2,095
38	1,173	1,353	1,443	1,533	1,624	1,713	1,849	1,985
40	1,115	1,285	1,371	1,457	1,543	1,628	1,757	1,885
44	1,013	1,169	1,247	1,324	1,403	1,480	1,597	1,715
50	892	1,028	1,097	1,165	1,235	1,303	1,405	1,508

THE WALCOTT CHAIN WARPER.

For a half a century or more the common method of making chain warps has been to wind from a creel containing from 40 to 240 spools, on a horizontal reel from 14 to 18 feet in diameter and about 7 feet high. By revolving the reel the ends, or threads, from the creel are laid on in courses from top to bottom, then reversing in the same spiral course to the top; continuing in this way until the required number of ends are laid on, the limit of length being governed by the circumference and height of the reel or "upright warper" as it is called; the largest size making a chain only 600 or 700 yards long.

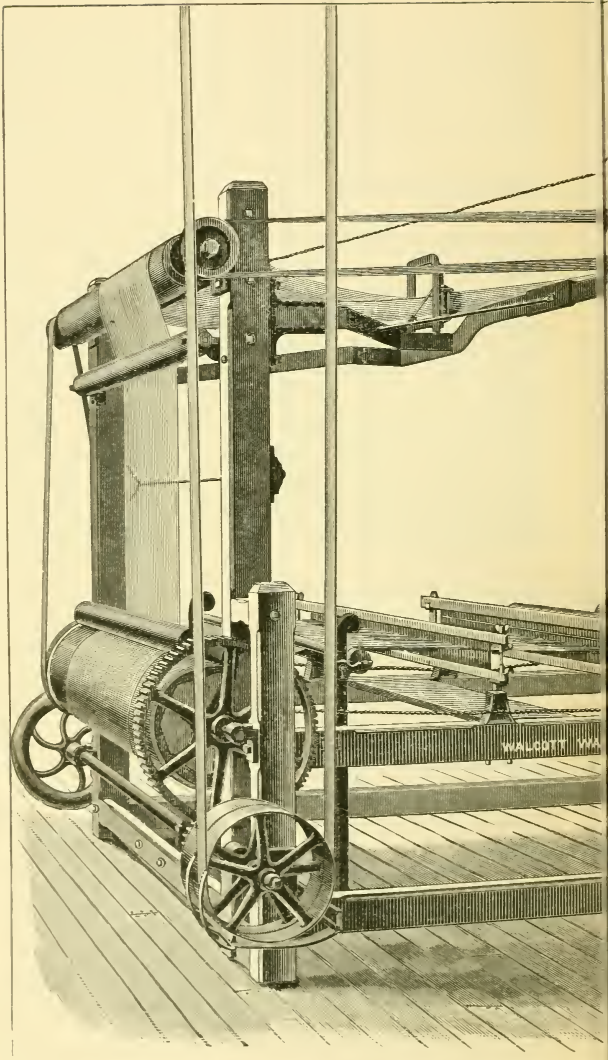
Instead of producing a chain limited to 600 or 700 yards in length, the continuous chain of the Walcott warper can be of any desired length, although usually made from 1200 to 1800 yards long. A full number of ends from the creel can be divided into any number of chains. If the chains are twice the usual length, one-half the beamers "twists" are saved and it is practical to save all the "twisting" on ginghams and fine yarns, except at the end of sections. The work of the beamers on continuous chains is so simplified that one beamer tender can do nearly the work of two, with less labor and perplexity.

The frame of the machine is only four feet wide and less than four feet from the floor to the ends between the measuring roll and draft roll, thus bringing each end under easy and perfect control of an ordinary-sized girl, who can do all the piecing and leasing in a convenient position at side of machine.

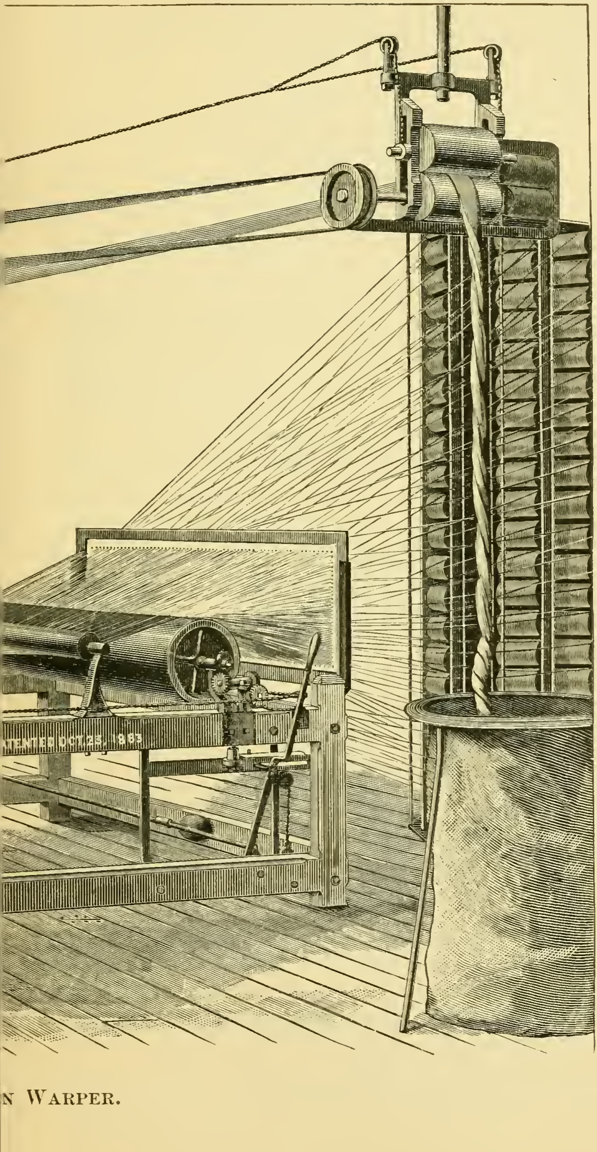
Chain warpers to deliver 2000 ends and upwards have been constructed, but in our opinion there is no economy in running over 1200 ends from one creel, principally because it is much more difficult to operate a machine carrying a larger number, and the extra time required for banking or tying in spools, with the necessary stops for piecing up, reduces the amount of product in a given time and increases its cost very largely.

Our illustration has this machine as made without stop motion. We have during the past ten years made and sold quite a number of these machines, and from our more extended experience recommend very strongly the application of the stop motion known as the "Walmsley," this being the only form of which we have any knowledge in which it is impossible to run the machine with a missing end.

The Walcott chain warper, with creel for twelve hundred spools, receiving bag and operator's position, occupies a space measuring about thirteen by thirty-two feet, eight and one-half feet high, and one machine will do more and better work than three reel or upright warpers. In fact, there can be no



Walcott



n Warper.

comparison between the two in quality of work, either on fine or coarse numbers, small or large chains.

References to parties who have run the Walcott warper and have it in use, will be given on application.

AUTOMATIC LINKER.

We have lately perfected a new Automatic Linker which, for simplicity and effectiveness, cannot be equalled. It produces links of uniform length which are easily pulled out and not liable to become tangled.

SPECIFICATIONS FOR WALCOTT CHAIN WARPER.

Number of chain warpers with driying pulleys on right hand side.

Number of chain warpers with driving pulleys on left hand side.

Number of ends to be run in each warper.

Number of deliveries for each warper.

Delivery and operator's position to be at (right or left) hand.

Pin lease for (3, 4, 5 or 6) ends.

Number of yarn to be run in each warper.

Number of yards in each cut.

Number of cuts in each chain.

Walmsley stop-motion.

Number of adjustable V creels. (Send sample spool marked with name of mill if creels are wanted).

Skewer bearings cut in creel stile.

Creel steps (of rawhide or glass).

Ship (in crates or taken down and boxed).

Do you want Linkers?

State distance between floors, as delivery is attached to floor above; or if delivery is to be attached to beams or stringers, state distance from floor up to them.

Ship via——.

Blank specification will be sent on application.

Length of warper frame, 10 feet, with stop-motion, 12 feet.

Space between holey board and creel, about 2 feet 6 inches.

Space between spools in creels, 18 and 20 spools high, ¾ inch; 14 and 16 spools high, 1 inch.

Holey board and lease reeds are 46 inches wide, and made to correspond with number of ends in creel.

If skewers are used they should be 1 1-16 inch longer than spools.

Driving pulley 10 inches in diameter for 2 inch belt.

DIMENSIONS OF CREELS FOR WALCOTT CHAIN WARPER.

No. of Ends.	No. Spools High.	No. Spools Long.	7½″ RUN, to carry spools with 3½″ head, 4½″ traverse.			8″ RUN, to carry spools with 4″ head, 5″ traverse.			8½″ RUN, to carry spools with 4″ head, 6″ traverse.			9″ RUN, to carry spools with 5″ head, 6″ traverse.		
			Length.	Width.	Height.	Length.	Width.	Height.	Length.	Width.	Height.	Length.	Width.	Height.
1200	20	30	18′ 3″	12′ 3″	7′ 6″	19′ 6″	13′ 0″	8′ 4″	20′ 8″	13′ 11″	8′ 4″	21′ 11″	14′ 5″	10′ 0″
1160	20	29	17′ 8″	11′ 11″	7′ 6″	18′ 10″	12′ 8″	8′ 4″	20′ 0″	13′ 6″	8′ 4″	21′ 2″	14′ 0″	10′ 0″
1120	20	28	17′ 1″	11′ 7″	7′ 6″	18′ 2″	12′ 3″	8′ 4″	19′ 4″	13′ 1″	8′ 4″	20′ 7″	13′ 7″	10′ 0″
1080	18	30	18′ 3″	12′ 3″	6′ 10″	19′ 6″	13′ 0″	7′ 7″	20′ 8″	13′ 11″	7′ 7″	21′ 11″	14′ 5″	9′ 1″
1044	18	29	17′ 8″	11′ 11″	6′ 10″	18′ 10″	12′ 8″	7′ 7″	20′ 0″	13′ 6″	7′ 7″	21′ 2″	14′ 0″	9′ 1″
1008	18	28	17′ 1″	11′ 7″	6′ 10″	18′ 2″	12′ 3″	7′ 7″	19′ 4″	13′ 1″	7′ 7″	20′ 7″	13′ 7″	9′ 1″
972	18	27	16′ 6″	11′ 3″	6′ 10″	17′ 6″	11′ 11″	7′ 7″	18′ 7″	12′ 8″	7′ 7″	19′ 10″	13′ 2″	9′ 1″
960	16	30	18′ 3″	12′ 3″	6′ 5″	19′ 6″	13′ 0″	7′ 1″	20′ 8″	13′ 11″	7′ 1″	21′ 11″	14′ 5″	8′ 5″
928	16	29	17′ 8″	11′ 11″	6′ 5″	18′ 10″	12′ 8″	7′ 1″	20′ 0″	13′ 6″	7′ 1″	21′ 2″	14′ 0″	8′ 5″
896	16	28	17′ 1″	11′ 7″	6′ 5″	18′ 2″	12′ 3″	7′ 1″	19′ 4″	13′ 1″	7′ 1″	20′ 7″	13′ 7″	8′ 5″
864	16	27	16′ 6″	11′ 3″	6′ 5″	17′ 6″	11′ 11″	7′ 1″	18′ 7″	12′ 8″	7′ 1″	19′ 10″	13′ 2″	8′ 5″
840	14	30	18′ 3″	12′ 3″	5′ 8″	19′ 6″	13′ 0″	6′ 3″	20′ 8″	13′ 11″	6′ 3″	21′ 11″	14′ 5″	7′ 5″
812	14	29	17′ 8″	11′ 11″	5′ 8″	18′ 10″	12′ 8″	6′ 3″	20′ 0″	13′ 6″	6′ 3″	21′ 2″	14′ 0″	7′ 5″
784	14	28	17′ 1″	11′ 7″	5′ 8″	18′ 2″	12′ 3″	6′ 3″	19′ 4″	13′ 1″	6′ 3″	20′ 7″	13′ 7″	7′ 5″
756	14	27	16′ 6″	11′ 3″	5′ 8″	17′ 6″	11′ 11″	6′ 3″	18′ 7″	12′ 8″	6′ 3″	19′ 10″	13′ 2″	7′ 5″
728	14	26	15′ 10″	10′ 11″	5′ 8″	16′ 11″	11′ 6″	6′ 3″	17′ 11″	12′ 3″	6′ 3″	19′ 1″	12′ 9″	7′ 5″
700	14	25	15′ 3″	10′ 7″	5′ 8″	16′ 3″	11′ 2″	6′ 3″	17′ 2″	11′ 11″	6′ 3″	18′ 4″	12′ 4″	7′ 5″
672	14	24	14′ 8″	10′ 4″	5′ 8″	15′ 8″	10′ 9″	6′ 3″	16′ 6″	11′ 7″	6′ 3″	17′ 7″	11′ 11″	7′ 5″
644	14	23	14′ 1″	10′ 0″	5′ 8″	15′ 0″	10′ 5″	6′ 3″	15′ 10″	11′ 2″	6′ 3″	16′ 10″	11′ 6″	7′ 5″
616	14	22	13′ 6″	9′ 8″	5′ 8″	14′ 5″	10′ 0″	6′ 3″	15′ 2″	10′ 9″	6′ 3″	16′ 1″	11′ 1″	7′ 5″
588	14	21	12′ 11″	9′ 4″	5′ 8″	13′ 9″	9′ 8″	6′ 3″	14′ 6″	10′ 4″	6′ 3″	15′ 3″	10′ 8″	7′ 5″

CLARKE'S PATENT BALLING MACHINE.

Within the past six years manufacturers of cotton goods using and dyeing chains have very generally adopted the long chain system, so called, in place of the short chain system which had been previously used. To-day there seems to be no doubt of the advantages and economy of the long chain system, and the only question is, What is the best way to make long chains?

Several years ago we began the manufacture of the Walcott Chain Warper for making these chains containing from 500 to 1200 ends. This machine is without a rival to-day for this kind of work. Many manufacturers, however, prefer to make their chains with a less number of ends, some of our prominent mills running 350 to 500 ends in a chain.

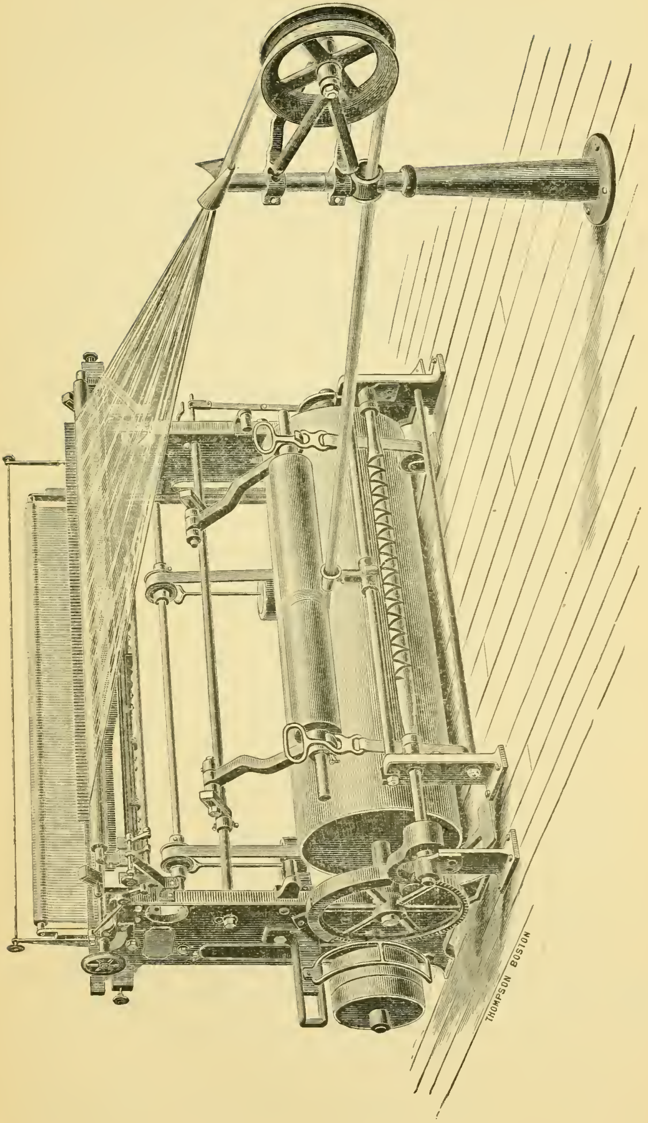
The simplest, cheapest, and most economical machine for doing this work, having in mind, first, the best possible results, and, second, to produce these results with the least possible labor and cost, is a combination of our improved slasher warper, which is so well known as to need no special comments, with the Straw leasing motion and clock, and the Clarke Balling Machine. By these arrangements we are enabled to procure chains weighing as high as 250 pounds or more without any slack threads, wound in the shape of balls, and with a thread lease taken at convenient intervals; and all this without adding materially to the cost of beam warping. The process is extensively in use in some of our best mills, and is giving entire satisfaction. We have sold a large number of warpers with these attachments, and a larger number of the attachments to be applied to beam warpers of other makes as well as our own. Various improvements have been made on this system until at last it has been, as we think, perfected; and we are now building warpers which require the smallest floor space, and give the very best results.

The operation of this balling machine is very simple: the ends are taken from spools in a creel through the regular slasher warper to the front comb, in place of which is the Straw leasing motion; after passing through this the ends are brought together in the trumpet and carried over the pulley as a chain and back to a trumpet which traverses the length of the ball back and forth on the same principle as the card-grinder.

The warper clock is adapted for stopping the machine so that a thread lease may be taken every 500 yards, or any other length that may be required.

Our cut does not show the more recent improvements.

For specifications see regular Warper specifications.


THOMPSON BOSTON

A NEW PROCESS IN CHAIN DYEING.

All manufacturers of colored goods, the yarns for which are bleached or dyed before using, are only too familiar with the constant annoyance and expense caused by the snarling and breaking of the yarn in the various processes of the dye house.

Since the introduction of chain quilling machines, by far the largest part of cotton yarns, both warp and filling, have been colored in the chain which, notwithstanding all its drawbacks, has been found on the whole the most economical method.

The most difficult and unsatisfactory process in all manufacturing has hitherto been the rewinding or beaming of the colored or bleached chains after they are returned from the dye house.

No one familiar with the manufacture of colored goods needs to be reminded of the endless number of broken and snarled chains, slack threads and twisted selvages which are continually turning up in the beaming room, however carefully the dye house is managed.

There has long been an urgent need of some process or method by which the excessive damage done to chains in the dye house might be avoided, and the following processes of manufacture be thus rendered less difficult.

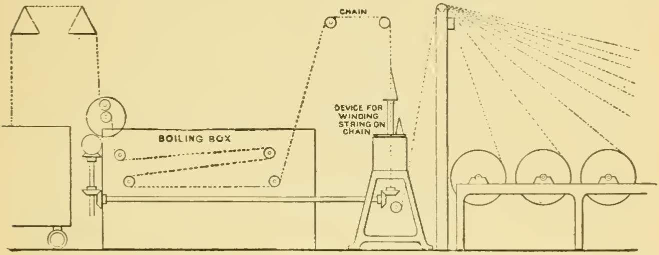
We are happy to be able to announce to our friends manufacturing colored goods, that this need has at length been supplied, and that we are now prepared to furnish them with methods and machines by the use of which the snarling and breaking of chains in the dye house can be practically entirely prevented.

Several years ago a Mr. Henry Gildard, employed at the time in one of our large colored mills, conceived the idea of winding or coiling around each chain from end to end a cord of suitable strength to hold the various threads together and prevent snarling and breaking in the dye house. The patents taken out by him are now in our hands.

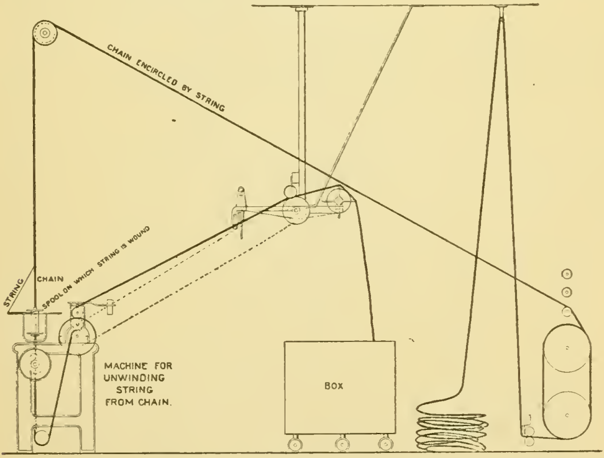
This method of treating the chain has been found to answer perfectly the purpose of preventing damage in the dye house, but the means at first used for putting on and removing the cord were so expensive and troublesome as to more than offset the advantages gained.

In June, 1894, these Gildard patents were bought by Mr. H. F. Straw, of the Amoskeag Company, and the machines necessary for putting on and taking off the cord have since been so perfected by him that a very large saving is effected by their use.

We believe we are well within bounds when we say that a net saving of at least one-half the whole cost of rebeaming may readily be made in the dressing room alone, and the gain in the weaving rooms, from the greatly improved preparation and the absence of knots and twists, should be nearly as much more.



This system of chain dyeing, including both the winding and unwinding process, has been used by the Amoskeag Company throughout their mills for the last year. As the Amoskeag Company is easily the largest in this country on this class of work, or indeed on cotton fabrics as a whole, their use of a method to such an extent should be a most convincing argument in its favor.


CHAIN ENCIRCLED BY STRING
STRING
CHAIN
SPOOL ON WHICH STRING IS WOUND
MACHINE FOR UNWINDING STRING FROM CHAIN.
BOX

The sketches we show in rough detail may help to give an idea of how the machines are used. The process is under our control through contracts with Mr. Straw, and it is fully covered by patents of Straw and others. We have orders at present from several large mills for sample sets of machines, and expect to introduce this process to a great extent on colored work.

The actual results in figures at the Amoskeag are such as to stamp this as one of the most important of recent textile inventions.

Any mill wishing to investigate this process, would do well to communicate with us, and we can send our expert to talk the matter over with them.

DIMENSIONS OF YARN REELS.

Size of ring .	1⅜	1½	1⅝	1¾	1⅞	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼	4½
Outside diameter of bobbin or cop	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼
Space between centres of spindles . .	2	2⅛	2¼	2⅜	2½	2⅝	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5
Number of spindles.	LENGTH OF REELS OVER ALL, IN FEET AND INCHES.															
25	....	....	....	....	....	....	....	9 3¾	9 9¾	10 3¾	10 9¾	11 3¾	11 9¾	12 3¾	12 9¾	13 3¾
30	....	....	....	9 0½	9 4¼	9 8	9 11½	10 6¾	11 2	11 9¼	12 4½	12 11¾	13 7	14 2¼	14 9½	15 4¾
35	....	9 4	9 8¼	10 0½	10 4¾	10 9	11 1¼	11 9¾	12 6¼	13 2¾	13 11¼	14 7¾	15 4¼	16 0¾		
40	9 9¾	10 2½	10 7½	11 0¼	11 5¼	11 10¼	12 3	13 0¾	13 10½	14 8¼	15 6	16 3¾				
45	10 7¾	11 1¼	11 6¾	12 0¼	12 5¾	12 11¼	13 4¾	14 3¾	15 2¾	16 1¾						
50	11 5¾	12 0	12 6	13 0	13 6¼	14 0¼	14 6½	15 6¾	16 7							
55	12 3¾	12 10½	13 5¼	14 0	14 6¾	15 1½	15 8¼									
60	13 1¾	13 9	14 4½	15 0	15 7¼	16 2¾										
65	13 11¾	14 7¾	15 3¾	15 11¾												
70	14 9¾	15 6½														
75	15 7¾															

WIDTH OF REELS, IN FEET AND INCHES.

Size of skein .	54 in.	60 in.	72 in	90 in.
Extreme width of reel . . .	2 9	2 10	3 8	3 8

We recommend maximum length of reel not to exceed 15 feet 6 inches.

Diameter of driving pulleys, 12 inches, with $1\frac{3}{4}$ inch face.

IMPROVED YARN REEL.

Our reel is constructed from entirely new designs, and is superior in most important points to all others, viz:—

The relative position of the different parts renders it much easier to operate than any other reel built.

The traverse motion is geared, and therefore positive, making it impossible to wind other than a well-bound skein; consequently, the process of spooling, or other succeeding operation, can be more rapid and less wasteful.

The bearing on driven end is set in ball and socket joint, so that it cannot be strained in lifting swift for removing yarn. The bearing on opposite end is entirely protected, preventing any oiling of skeins.

The releasing arms and traverse are furnished with metal bearings, fitted in metal boxes.

The shaft is of wood with transverse grain, insuring lightness, and for the purpose superior to any other material.

The bobbin box has waste box at each end, and is protected from any drip from spindles.

We make them fitted with either Sawyer, Rabbeth or common spindles, each spindle removable independent of others. Spindle bearings have hinged protecting board, preventing dirt and flyings from lodging.

A gong is attached to strike at the completion of each hank of 840 yards or when any other length desired has been reeled. We recommend maximum length of reel not to exceed 65 spindles, with 2¼ inch space, length over all 15 feet 3¾ inches; total width for 54-inch skein, 2 feet 9 inches.

For reasons above detailed, we claim a larger production in better condition, in a given time, with less waste.

SPECIFICATION FOR REELS.

Number of reels with driving pulleys on right hand end.

Number of reels with driving pulleys on left hand end.

Number of spindles in each reel.

Size of skein desired (54, 60, 72, or 90 inch).

Reel to be belted from (above or below).

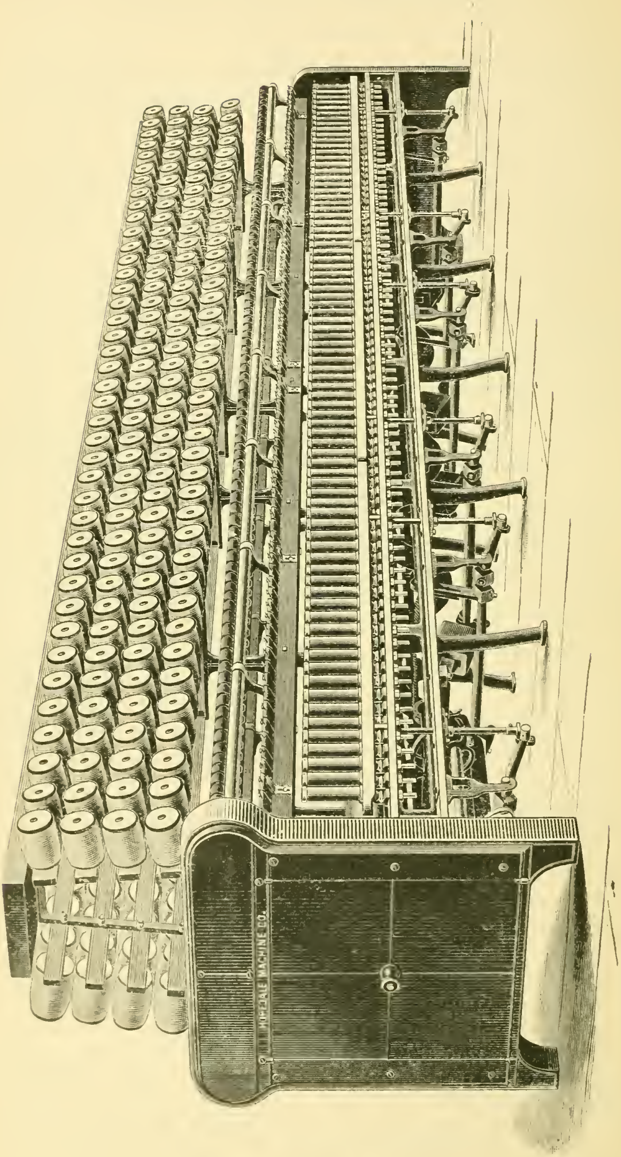
Gong to strike at each (hank or —— yards).

Yarn to be reeled from (spool, bobbin, or cop). Send sample full of yarn.

Reels to be shipped (on shoes, in crates, or taken down and boxed).

Ship via ——.

Blank specification will be sent on application.


HOPEDALE MACHINE CO.

HOPEDALE TWISTER.

TWISTERS.

We control the sale of the Twisters manufactured by the Hopedale Machine Co. Their skill and our requirements have united in producing an unequalled machine. If there is one single point in which competing twisters lead our present manufacture, it is one which has never been brought to our attention. Referring to the various details of manufacture, we will briefly notice the most prominent features.

THE FRAME.

Many would consider the design of the framework of a twister of little importance. We, however, consider it vital. A twister is subject to far greater rack and strain than a spinning frame. The spindles are heavier and carry more weight. They take more power, and so does the rest of the machine. It is a common custom to make twisters, using the framework of a spinning frame on which to build the rest. The result must be jar and strain, spindles out of center, bearings cramped, and wear inevitable.

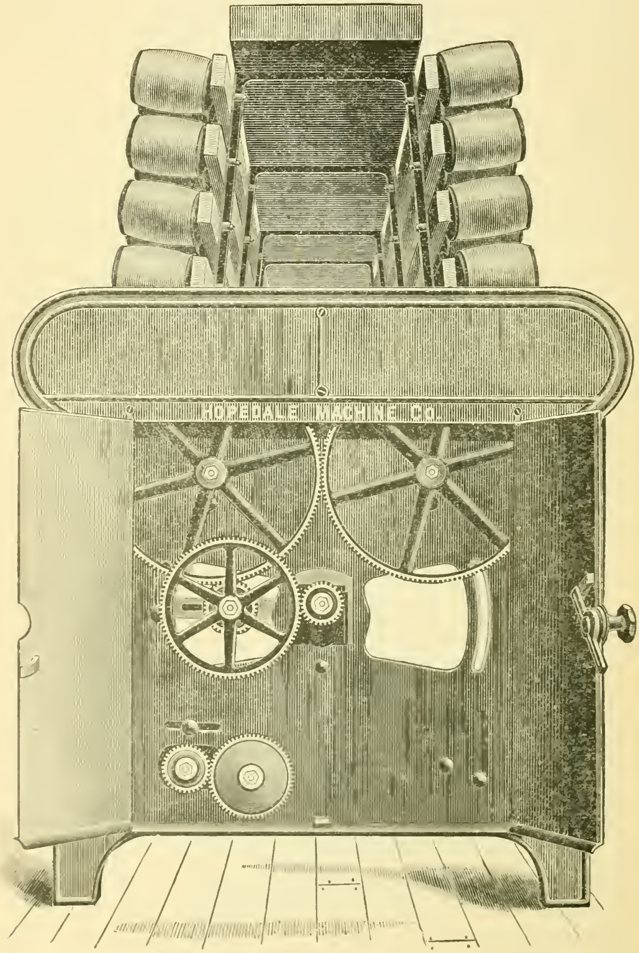
Our frame was specially designed. There is more cast iron in it than in any other we have seen. We believe in cast iron properly distributed, and have a machine that stays plumb and runs smoothly. It is mechanical and well proportioned. We are aware that this extra weight means so much extra cost per pound to us (not to our customers), but have our reputation to consider.

THE GEARING.

As the gearing controls the twist, and as twisting is the function of the machine, the subject is entitled to inspection. The simplicity of the arrangement must commend itself.

It will be observed that we have placed the twist gear directly on the end of the cylinder shaft, interposing between the gear and the cylinder proper the cylinder bearing. This does away with a large part of the noise of the machine. In arranging the twist gears, it will be seen that the gear on the end of the cylinder, being the twist gear proper, meshes into a gear fast to a stud on a stand, and that on the stud with this intermediate first spoken of, is a gear which meshes into the large intermediate which drives the roll gear. This arrangement enables us to vary our twist in the proportion of 25 to one without making any change beyond the change of the twist gear proper, and the two gears held on the stand. Or we can make a change of nearly 5 to one without change, except the change of the twist gear proper. This, we think, is a higher range than has been accomplished on any other machine.

Again, our arrangement of fastening the gears between the twist gear proper and the large intermediate is such that we are enabled to run them perfectly free without cramp, and without any liability of their working together, as is ordinarily the case. All our gearing is machine cut, and well protected from dirt.

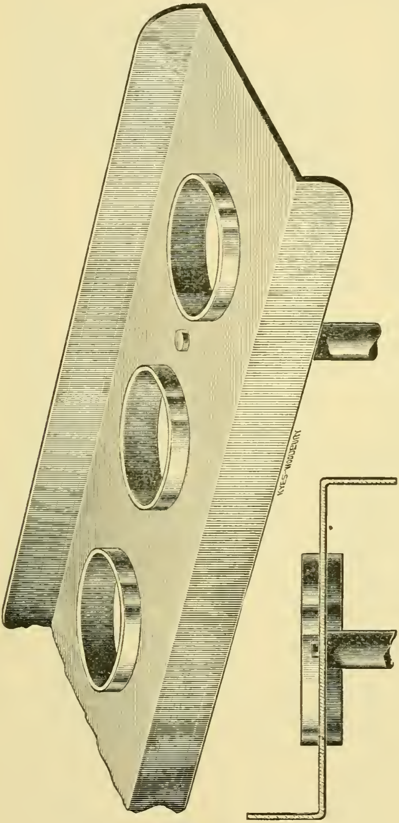

HOPEDALE MACHINE CO.

GEARED END OF TWISTER

BUILT BY THE HOPEDALE MACHINE COMPANY.

THE WORKMANSHIP.

It would be a strange event when our machines were criticised on this point. Our castings are made from accurate patterns and we plane, mill and fit with absolute closeness.



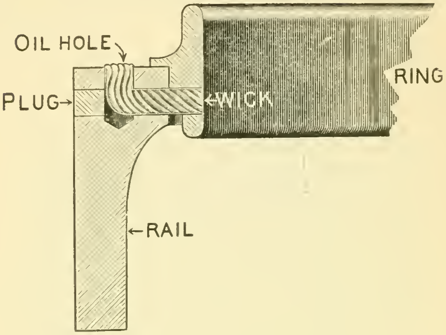
Patent Ring Rail.

THE RINGS

Are mainly our own product, and we guarantee them in every particular. We make all styles, and have some very important novelties.

Our patent combined vertical ring and ring rail has had a well merited success. It is the invention of Mr. Geo. Otis Draper of our firm, and by its use the rings are made reversible for double wear by simply turning the rail over. This is the simplest and easiest rail to clean or wash, and is stiff beyond any possible requirement. The cut is self explanatory.

CARTER OILING DEVICE FOR VERTICAL TWISTER RINGS.



ANOTHER DECIDED NOVELTY

Is the Carter self-oiling ring to be used on vertical rings of 3 inches diameter, or over. On this class of ring, this device is a positive necessity, as it adds several per cent. to the possible speed, and makes the work run far better. As is seen in the cut, it consists of a wick inserted in a hole in the ring flange and rail to grease the traveler. Although simple, it is efficient and well patented. Our customers who have once used it will not do without it.

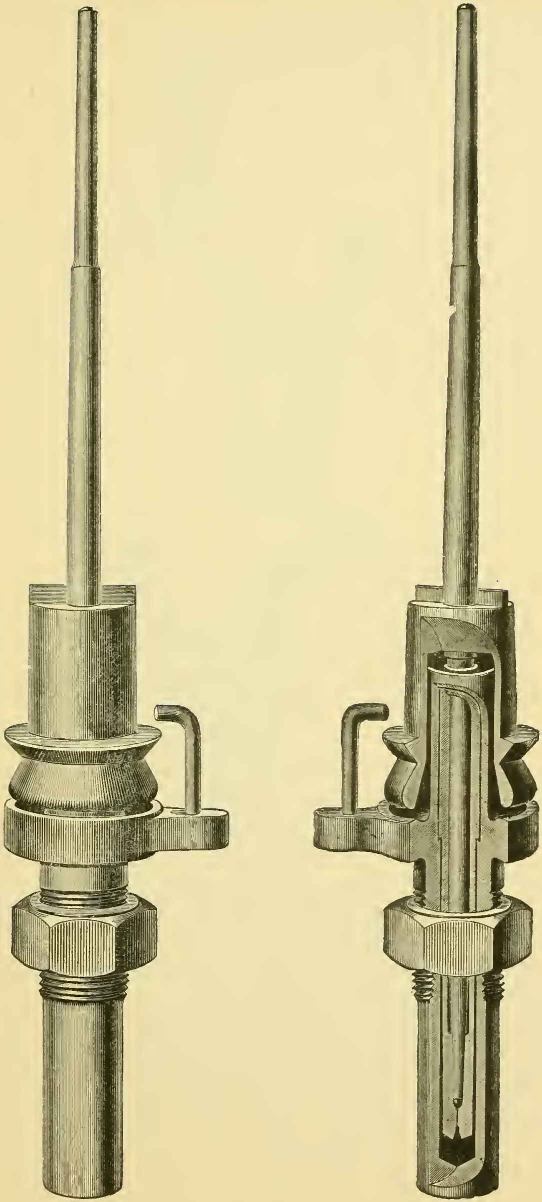
THE SPINDLES

Are manufactured by the Hopedale Machine Company, the largest producers in the world. Our firm inspects their product, which is a safeguard other manufacturers can not equal who simply pass judgment on their *own* product.

We furnish any spindle requested, which offers a larger field for selection than other manufacturers. We usually recommend the Sherman for ordinary requirements. For very heavy work, the Sawyer is well adapted.

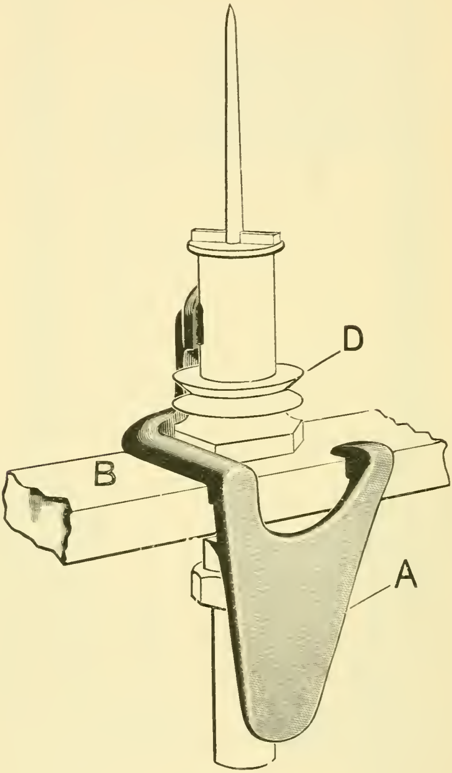
Some manufacturers think to save money in the first cost by ordering Common spindles in their twisters. They might as well buy hand looms for their weaving department. They will lose in absolute first cost, as more machines are necessary to do the same work, more floor space required, etc. When it comes to running them, the extra help, power, supplies and incidentals make the comparison laughable.

For the benefit of those unacquainted with the progress in this line, we will state that the modern spindle runs 20 to 40 per cent. faster than the Common, without taking any more



Sherman Twister Spindles.

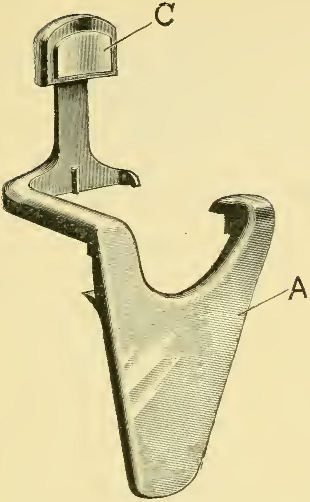
power or attendance *per spindle.* It will also wear longer, require oiling less frequently, and give better satisfaction in every particular.



THE BRAKE.

We have purchased the exclusive American right to use the Hetherington Spindle Brake, a very neat invention of decided merit. When large, heavy spindles are used, it is a necessity for the operative to have an aid to keep the spindle from turning while piecing up. This Brake is a simple casting with leather friction pad, and performs the double duty of brake and spindle retainer. By simply tilting the casting, the spindle can be removed or raised. Nothing simpler could possibly be devised. As a Brake it is worked by knee pressure.

The cut above shows the Brake in position. A is the casting, B the rail, and D the spindle. On next page is shown the casting alone. C shows the friction leather pad.



THE TRAVERSE.

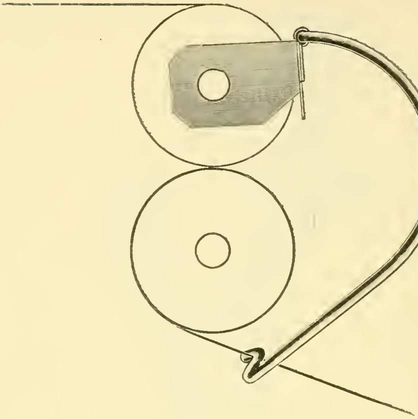
The gearing which operates the traverse motion can be easily changed to accommodate the work being done. A large gain in the amount of yarn wound on the bobbins is possible by adapting the traverse properly, and a gain of 15 or 20 per cent. is sometimes made in this way.

It is common to run the traverse the same speed for 4-ply 20s. as for 2-ply 40s. It is impossible to run the speed of traverse as slow on 4-ply 20s. as it should be run on 2-ply 40s., for the reason that the yarn will break in spooling if it is wound under and "piled" on the bobbin. It is wasteful to run the traverse as fast for 2-ply 40s. as for 4-ply 20s., because 15 or 20 per cent. less yarn will be put on the bobbin, which means a smaller production for the twister, more knots in the product, and a higher cost in the subsequent processes because of the shorter length of yarn handled.

We also have a new improvement, consisting in a simple lever clutch, by which the worm operating the traverse can be dropped out of gear, allowing the ring rail to be lowered at any time, saving several minutes per day over the old custom of stopping the frames at closing time, when the rails were natually at the low traverse.

THE SPECIALTIES.

We have many patented contrivances only used on special work, but of peculiar advantage in special instances.



THE T. H. SMITH STOP MOTION.

The trade has long waited for an efficient stop motion to prevent waste on twisters when an end breaks. Waste made at the twisters is both costly and worthless. Spinning frame waste can be spun over again, while twister waste is only fit for cleaning purposes.

Mr. T. H. Smith of the Jamestown (New York) Cotton Mill has invented a very simple and practical stop motion. It consists, as may be seen in the cut, of a wire leg and sheet metal holder adapted to pivot on the upper roll bearing; the sheet metal part also holding a leather tongue which is normally held out of contact with the rolls when the leg is resting its lower end on the yarn being twisted; when the yarn breaks the leg drops and the leather tongue is fed in between the rolls, effectually preventing delivery.

The device can be applied to twisters now in use without any mechanical change, and its advantages are enormous in comparison with its cost. Some of them are as follows:

When an end breaks down between the rolls and guide wire the top roll is instantly stopped and all waste or roller laps prevented. On two-ply work it will act on the breakage of either strand. The top roll is not lifted out of its place at any time and the yarn is not liable to be cut as it often is in replacing the roll. There are fewer breakages of ends while the frame is running because the leg of the attachment acts as a kind of evener, giving and taking as an end tightens or slackens, and it can run more spindles because the frames run better and there are no laps to cut on the rolls, and the rolls are not scored and roughened by cutting. The frames can also be run faster. It is possible to run the frames without stopping from doff to doff, as the ends can be tied up easily with the frame running as they do not lash around and break others. It is not necessary to wind double with a stop motion spooler if this device is used. On an actual test of a four weeks' run, 6 frames with this stop motion averaged 38¼ oz. of waste against 138 oz. made on one frame without a stop motion.

We are the sole agents for this important improvement. We think any mill using twisters will make a great mistake not to investigate this idea. Sample lots can be very easily tried and the expense is not large.

IN GENERAL.

Parties desiring twisters can make no mistake by applying to us. We have made them for over twenty years, and have been second to none. Our prices are not higher than other first-class builders. While we can confidently assert that we can supply machinery that will do all any competing machine can accomplish, the reverse is by no means a similar tale. Our patented novelties are exclusive for our own machines.

If interested in purchase of new twisters, send immediately for our specification blank.

DIMENSION OF TWISTERS.

These are figured for 2¼ inch pulleys. If other width pulleys are ordered, add to these figures for length, twice the extra width of a pulley. Example—with 3 3-4 inch pulleys, add 3 inches.

Size of Ring	1¾ in.	2 in.	2¼ in.	2½ in.	3 in.	3½ in.	4 in.	4½ in.
Space between centres of spindles, or guage	2¾ in.	3 in.	3¼ in.	3½ in.	4 in.	4½ in.	5 in.	5½ in.
* Total width	3 ft. 3½ in.	3 ft. 3¾ in.	3 ft. 4 in.	3 ft. 4¼ in.	3 ft. 4¾ in.	3 ft. 5¼ in.	3 ft. 5¾ in.	3 ft. 6⅜ in.
Approximate weight per spindle in pounds	21	24	27	30	33	36	39	42
Number of Spindles.	LENGTH OF TWISTERS OVER ALL, IN FEET AND INCHES.							
240	29 6	32 0						
220	27 2½	29 6	31 9½					
200	24 11	27 0	29 1	31 2				
180	22 7½	24 6	26 4½	28 3	32 0			
160	20 4	22 0	23 8	25 4	28 8	32 0		
144	18 6	20 0	21 6	23 0	26 0	29 0	32 0	
140	18 0½	19 6	20 11½	22 5	25 4	28 3	31 2	
128	16 8	18 0	19 4	20 8	23 4	26 0	28 8	31 4
120	15 9	17 0	18 3	19 6	22 0	24 6	27 0	29 6
112	14 10	16 0	17 2	18 4	20 8	23 0	25 4	27 8
108	14 4½	15 6	16 7½	17 9	20 0	22 3	24 6	26 9
100	13 5½	14 6	15 6½	16 7	18 8	20 9	22 10	24 11
96	....	14 0	15 0	16 0	18 0	20 0	22 0	24 0
90	....	....	14 2¼	15 1½	17 0	18 10½	20 9	22 7½
84	....	....	....	14 3	16 0	17 9	19 6	21 3
80	....	....	....	13 8	15 4	17 0	18 8	20 4
72	....	....	....	....	14 0	15 6	17 0	18 6
64	....	....	....	....	....	14 0	15 4	16 8

To ascertain the length of Twister, with any number of spindles: Multiply one-half the number of spindles by the distance between centres of spindles, add 24, and divide by 12; the quotient and remainder will be the total length in feet and inches.

Diameter of driving pulleys 8 to 14 inches, with 2 1-4-inch face. Cylinders are 8 inches in diameter unless otherwise specified.

* Width of Twister on floor 3 feet, 2 inches; the ring rails project beyond other parts, making total width as given above for all sizes at ring rail. The width of head end on level with front roll is 3 feet. 7 3-4 inches. This is the regular width. We make others to order when specified.

Table of Twist Gears for Hopedale Machine Company's Twister.

This table gives the number of teeth required in cylinder gears with a given stud gear to produce a theoretical twist with 8-inch cylinder and ⅛-inch band. No allowance is made for contraction.

Diameter of whirl . . .	2½	2¼	1¾	1¼	1⅛	1	⅞
Teeth in stud gear . . .	36	32	36	38	32	28	26
Teeth in cylinder gear.	TWIST.						
18	10.95	13.61	15.33	19.80	25.86	32.85	39.79
19	10.37	12.90	14.52	18.77	24.50	31.12	37.54
20	9.85	12.25	13.79	17.82	23.28	29.56	35.81
21	9.38	11.67	13.14	16.97	22.17	28.15	34.11
22	8.95	11.14	12.54	16.20	21.16	26.87	32.55
23	8.57	10.65	11.99	15.50	20.24	25.70	31.14
24	8.21	10.21	11.49	14.85	19.40	24.63	29.84
25	7.88	9.80	11.03	14.25	18.62	23.65	28.65
26	7.58	9.42	10.61	13.70	17.90	22.74	27.55
27	7.30	9.07	10.22	13.19	17.24	21.90	26.53
28	7.04	8.75	9.85	12.71	16.63	21.12	25.58
29	6.79	8.45	9.52	12.29	16.05	20.39	24.70
30	6.57	8.17	9.20	11.88	15.52	19.70	23.87
31	6.36	7.90	8.90	11.50	15.02	19.06	23.10
32	6.16	7.66	8.62	11.14	14.55	18.47	22.38
33	5.97	7.42	8.36	10.80	14.11	17.91	21.70
34	5.80	7.21	8.11	10.48	13.69	17.38	21.06
35	5.63	7.00	7.88	10.18	13.30	16.89	20.46
36	5.47	6.81	7.66	9.90	12.93	16.42	19.89
37	5.33	6.62	7.45	9.63	12.58	15.98	19.36
38	5.19	6.45	7.26	9.38	12.25	15.56	18.85
39	5.06	6.28	7.08	9.14	11.94	15.16	18.36
40	4.93	6.13	6.90	8.91	11.64	14.78	17.90
41	4.81	5.98	6.73	8.69	11.35	14.42	17.47
42	4.69	5.83	6.57	8.48	11.08	14.07	17.05
43	4.58	5.70	6.42	8.29	10.83	13.75	16.66
44	4.48	5.57	6.27	8.10	10.58	13.44	16.28
45	4.38	5.44	6.13	7.94	10.35	13.14	15.92
46	4.29	5.33	6.00	7.75	10.12	12.86	15.57
47	4.20	5.21	5.87	7.58	9.90	12.58	15.24
48	4.11	5.10	5.75	7.42	9.70	12.32	14.92
49	4.02	5.00	5.63	7.28	9.50	12.07	14.62
50	3.94	4.90	5.52	7.13	9.31	11.82	14.32
51	3.87	4.80	5.41	6.98	9.13	11.59	14.04
52	3.79	4.71	5.31	6.85	8.95	11.37	13.77

The ordinary ranges of twist required, corresponding to the Tables of Production, are given in the above table. If any twist not given is necessary it can be obtained within a small fraction of a turn, by changing both stud and cylinder gears. All gears are interchangeable, and have same size nut requiring but one size of wrench to make any change.

SPECIFICATIONS FOR TWISTERS.

How many Wet Twisters?
How many Dry Twisters?
How many Spindles in each?
What pattern of spindle? (Sherman, Sawyer, etc.)
Single or double Boss Top Rolls?
Single or double Line Bottom Rolls?
What Gauge?
Kind of Ring? (Vertical, or flat-top.)
Size of Ring?
What length traverse?
Will you have Warp or Filling wind?
Will you have Single or Double-Headed Bobbin?
What number yarn will you twist?
How many ply?

For how many turns twist per inch shall Twisters be geared?

Will you twist from beams or spools?
How belted, from Above or Below?
Are brakes required on spindles?
Are bottom rolls to run in water pan?
If you twist from spool, send sample.
Single or double cylinder?

Cylinders on new pattern Twisters, unless otherwise specified, are 8 inches diameter.

Pulleys run from 8 to 20 inches, 2¼ inch faces, what size will you have?

Is a narrower width than our regular size twister required?
Shall machines be Crated, Shod, or taken down and Boxed?
By what lines shall we make shipment?
Blank specification sent on request.

☞ We recommend 12 inch or *larger* pulleys.
In sending Spools, please specify on same where from.

In preparing tables of production of our twisters we have assumed the number of the yarn after twisting to be one half for 2-ply, and one fourth for 4-ply, of the number before twisting; the twist is indicated by the number at the head of the table by which the square root of the twisted yarn is multiplied. (See twist tables on pages 158-162.) The table covers the most common sizes of ring and numbers of yarn. What we consider to be a fair allowance for loss by all causes from the theoretical production has been made. With this explanation we submit the following table:—

Production of Hopedale Twisters in pounds per spindle per week of sixty hours.

Size of spindle	No. 3 Sawyer.															
Rev. per { spindle . . .	1800		2600				3400				4200					
minute { cylinder . . .	582		760				785				711					
Diameter of whirl . . .	2½ in.		2¼ in.				1¾ in.				1¼ in.					
Gauge.	5½ in.		5 in.				4½ in.				4 in.					
Diameter of ring	4½ in.		4 in.				3½ in.				3 in.					
Diameter of bobbin .	Head, 4¼ in. Barrel, 1¾ in.		Head, 3¾ in. Barrel, 1¾ in.				Head, 3¼ in Barrel, 1¼ in.				Head, 2¾ in. Barrel, 1¼ in.					
Length of traverse . . .	6 in.		6 in.				6 in				5½ in.					
Weight of yarn on bobbin	1.197 lbs.		.873 lbs.				.74 lbs.				.46 lbs.					
Number of ply	6		4		6		3		4		2		3		4	
Twist = sq. root of number of twisted yarn ×	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5
Number of yarn to be twisted. 6	46.10	37.28	36.10	29.21	....	....	30.92	25.03	....	....	20.87	16.91				
7	36.99	29.85	28.98	23.40	....	....	24.83	20.05	....	....	16.78	13.57				
8	30.51	24.58	23.93	19.29	....	....	20.50	16.53	30.92	25.03	13.86	11.18				
9	25.72	20.70	20.17	16.24	....	....	17.29	13.92	26.16	21.13	11.70	9.42	20.87	16.91		
10	22.06	17.73	17.31	13.92	31.08	25.11	14.83	11.93	22.49	18.15	10.04	8.08	17.99	14.55		
11	19.18	15.41	15.06	12.10	27.12	21.88	12.90	10.37	19.61	15.80	8.73	7.02	15.70	12.68		
12	16.88	13.56	13.25	10.65	23.93	19.29	11.36	9.12	17.29	13.92	7.69	6.18	13.86	11.18	20.87	16.91
13	....	....	....	....	21.31	17.16	....	....	15.39	12.38	....	....	12.35	9.96	18.64	15.08
14	....	....	....	....	19.14	15.40	....	....	13.81	11.10	....	....	11.10	8.94	16.78	13.56
15	....	....	....	....	17.31	13.92	....	....	12.48	10.03	....	....	10.04	8.08	15.21	12.28
16	....	....	....	....	15.75	12.66	....	....	11.36	9.12	....	....	9.14	7.35	13.86	11.18
17	....	....	....	....	14.41	11.58	....	....	....	....	....	....	8.36	6.72	12.70	10.24
18	....	....	....	....	13.25	10.65	....	....	....	....	....	....	7.69	6.18	11.70	9.42
19	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10.82	8.71
20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10.04	8.08
21	....	....	....	....	....	....	....	....	....	....	....	....	....	....	9.35	7.52
22	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8.74	7.03
23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8.19	6.58
24	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7.69	6.18

Production of Hopedale Twisters in pounds per spindle per week of sixty hours. — *Continued.*

Size of spindle							No. 27 Sherman.					
Rev. per minute { spindle	5000						5500				6000	
Rev. per minute { cylinder	769						846				831	
Diameter of whirl	1 1/8 in.						1 1/8 in.				1 in.	
Gauge	3 1/2 in.						3 1/4 in.				3 in.	
Diameter of ring	2 1/2 in.						2 1/4 in.				2 in.	
Diameter of bobbin	Head, 2 1/4 in. Barrel, 7/8 in.						Head, 2 in. Barrel, 7/8 in.				Head, 1 3/4 in. Barrel, 3/4 in.	
Length of traverse	5 1/2 in.						5 1/2 in.				5 in.	
Weight of yarn on bobbin	.334 lbs.						.255 lbs.				.182 lbs.	
Number of ply	2		3		4		2		3		2	
Twist = sq. root of number of twisted yarn ×	4	5	4	5	4	5	5	6	5	6	5	6
Number of yarn to be twisted. 8	16.21	13.15										
9	13.74	11.12										
10	11.83	9.56										
11	10 32	8.33										
12	9.10	7.34	16.21	13.15	....	....	8.04	6.75				
13	8.11	6.53	14.49	11.73	....	....	7.16	6.01				
14	7.28	5.86	13.05	10.55	....	....	6.44	5.40				
15	6.59	5.30	11.83	9.56	....	....	5.82	4.88				
16	5.99	4.82	10.78	8.71	16.21	13.15	5.30	4.44				
17	...	...	9.89	7.97	14.89	12.06	4.85	4.06				
18	...	...	9.10	7.34	13.74	11.12	4.46	3.74	8.04	6.75		
19	...	...	8.42	6.78	12.72	10.28	4.12	3.45	7.44	6.24		
20	...	...	7.82	6.29	11.83	9.56	3.83	3.20	6.91	5.79	4.17	3.49
21	...	...	7.28	5.86	11.03	8.91	3.56	2.98	6.44	5.40	3.88	3.25
22	...	...	6.81	5.47	10.32	8.33	3.32	2.78	6.02	5.04	3.63	3.04
23	...	...	6.38	5.13	9.68	7.81	3.11	2.60	5.64	4.72	3.40	2.84
24	...	...	5.99	4.82	9.10	7.34	2.93	2.44	5.30	4.44	3.19	2.67

Production of Hopedale Twisters in pounds per spindle per week of sixty hours. — *Continued.*

Size of spindle				No. 27 Sherman.											
Rev. per minute, spindle		5000		5500				6000				6800			
Rev. per minute, cylinder		769		846				831				837			
Diameter of whirl		1⅛ in.		1⅛ in.				1 in.				⅞ in.			
Gauge		3½ in.		3¼ in.				3 in.				2¾ in.			
Diameter of ring		2½ in.		2¼ in.				2 in.				1¾ in.			
Diameter of bobbin		Head, 2¼ in. Barrel, ⅞ in.		Head, 2 in. Barrel, ⅞ in.				Head, 1¾ in. Barrel, ¾ in.				Head, 1½ in. Barrel, ¾ in.			
Length of traverse		5½ in.		5½ in.				5 in.				5 in.			
Weight of yarn on bobbin		.334 lbs.		.255 lbs.				.182 lbs.				.125 lbs.			
Number of ply		4		2		3		2		3		2		3	
Twist = sq. root of number of twisted yarn ×		4	5	5	6	5	6	5	6	5	6	5	6	5	6
Number of yarn to be twisted.	25	8.58	6.92	2.75	2.30	5.00	4.18	3.01	2.52						
	26	8.11	6.53	2.60	2.17	4.72	3.95	2.84	2.37						
	27	7.68	6.18	2.46	2.05	4.46	3.74	2.69	2.25						
	28	7.28	5.86	2.33	1.94	4.23	3.54	2.55	2.13						
	29	6.92	5.57	...	...	4.02	3.36	2.42	2.02						
	30	6.59	5.30	...	...	3.83	3.20	2.30	1.92	4.17	3.49				
	32	5.99	4.82	...	...	3.48	2.91	2.09	1.75	3.79	3.18				
	34	...	...	...	...	3.18	2.66	1.91	1.60	3.47	2.91				
	36	...	...	...	...	2.93	2.44	1.76	1.47	3.19	2.67				
	38	...	...	...	...	2.70	2.26	1.62	1.35	2.95	2.47				
	40	...	...	...	...	2.50	2.09	1.50	1.26	2.74	2.29	1.69	1.41		
	42	...	...	...	...	2.33	1.94	1.40	1.17	2.55	2.13	1.57	1.32		
	44	...	...	...	...	...	...	1.31	1.09	2.38	1.99	1.47	1.23		
	46	...	...	...	...	...	...	1.22	1.02	2.23	1.86	1.38	1.15		
	48	...	...	...	...	...	...	1.15	.96	2.09	1.75	1.29	1.08		
	50	...	...	...	...	...	...	1.08	.90	1.97	1.65	1.22	1.02	2.21	1.85
	60	...	...	...	...	...	...	...	...	1.50	1.26	.93	.78	1.69	1.41
	70	...	...	...	...	...	...	...	...	...	...	.74	.62	1.35	1.13
	80	...	...	...	...	...	...	...	...	...	...	.61	.51	1.11	.92

TWO PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	**5**	**6**				**5**	**6**
1	.5	.7071	2.83	3.54	4.24	76	38.	6.1644	30.82	36.99
2	1.	1.	4.	5.	6.	77	38.5	6.2049	31.02	37.23
3	1.5	1.2247	4.90	6.12	7.35	78	39.	6.2450	31.22	37.47
4	2.	1.4142	5.66	7.07	8.49	79	39.5	6.2849	31.42	37.71
5	2.5	1.5811	6.32	7.91	9.49	**80**	40.	6.3246	31.62	37.95
6	3.	1.7321	6.93	8.66	10.39	81	40.5	6.3640	31.82	38.18
7	3.5	1.8708	7.48	9.35	11.22	82	41.	6.4031	32.02	38.42
8	4.	2.	8.	10.	12.	83	41.5	6.4420	32.21	38.65
9	4.5	2.1213	8.49	10.61	12.73	84	42.	6.4807	32.40	38.88
10	5.	2.2361	8.94	11.18	13.42	85	42.5	6.5192	32.60	39.12
11	5.5	2.3452	9.38	11.73	14.07	86	43.	6.5574	32.79	39.34
12	6.	2.4495	9.80	12.25	14.70	87	43.5	6.5955	32.98	39.57
13	6.5	2.5495	10.20	12.75	15.30	88	44.	6.6332	33.17	39.80
14	7.	2.6458	10.58	13.23	15.87	89	44.5	6.6708	33.35	40.02
15	7.5	2.7386	10.95	13.69	16.43	**90**	45.	6.7082	33.54	40.25
16	8.	2.8284	11.31	14.14	16.97	91	45.5	6.7454	33.73	40.47
17	8.5	2.9155	11.66	14.58	17.49	92	46.	6.7823	33.91	40.69
18	9.	3.	12.	15.	18.	93	46.5	6.8191	34.10	40.91
19	9.5	3.0822	12.33	15.41	18.49	94	47.	6.8557	34.28	41.13
20	10.	3.1623	12.65	15.81	18.97	95	47.5	6.8920	34.46	41.35
21	10.5	3,2404	12.96	16.20	19.44	96	48.	6.9282	34.64	41.57
22	11.	3.3166	13.27	16.58	19.90	97	48.5	6.9642	34.82	41.79
23	11.5	3.3912	13.56	16.96	20.35	98	49.	7.	35.	42.
24	12.	3.4641	13.86	17.32	20.78	99	49.5	7.0356	35.18	42.21
25	12.5	3.5355	14.14	17.68	21.21	**100**	50.	7.0711	35.36	42.43
26	13.	3.6056	14.42	18.03	21.63	101	50.5	7.1063	35.53	42.64
27	13.5	3.6742	14.70	18.37	22.05	102	51.	7.1414	35.70	42.85
28	14.	3.7417	14.97	18.71	22.45	103	51.5	7.1763	35.88	43.06
29	14.5	3.8079	15.23	19.04	22.85	104	52.	7.2111	36.06	43.27
30	15.	3.8730	15.49	19.37	23.24	105	52.5	7.2457	36.23	43.47
31	15.5	3.9370	15.75	19.69	23.62	106	53.	7.2801	36.40	43.68
32	16.	4.	16.	20.	24.	107	53.5	7.3144	36.57	43.89
33	16.5	4.0620	16.25	20.31	24.37	108	54.	7.3485	36.74	44.09
34	17.	4.1231	16.49	20.62	24.74	109	54.5	7.3824	36.91	44.29
35	17.5	4.1833	16.73	20.92	25.10	**110**	55.	7.4162	37.08	44.50
36	18.	4.2426	16.97	21.21	25.46	111	55.5	7.4498	37.25	44.70
37	18.5	4.3012	17.20	21.51	25.81	112	56.	7.4833	37.42	44.90
38	19.	4.3589	17.44	21.79	26.15	113	56.5	7.5166	37.58	45.10
39	19.5	4.4159	17.66	22.08	26.50	114	57.	7.5498	37.75	45.30
40	20.	4.4721	17.89	22.36	26.83	115	57.5	7.5829	37.91	45.50
41	20.5	4.5277	18.11	22.64	27.17	116	58.	7.6158	38.08	45.69
42	21.	4.5826	18.33	22.91	27.50	117	58.5	7.6485	38.24	45.89
43	21.5	4.6368	18.55	23.18	27.82	118	59.	7.6811	38.41	46.09
44	22.	4.6904	18.76	23.45	28.14	119	59.5	7.7136	38.57	46.28
45	22.5	4.7434	18.97	23.72	28.46	**120**	60.	7.7460	38.73	46.48
46	23.	4.7958	19.18	23.98	28.77	121	60.5	7.7782	38.89	46.67
47	23.5	4.8477	19.39	24.24	29.09	122	61.	7.8102	39.05	46.86
48	24.	4.8990	19.60	24.49	29.39	123	61.5	7.8422	39.21	47.05
49	24.5	4.9497	19.80	24.75	29.70	124	62.	7.8740	39.37	47.24
50	25.	5.	20.	25.	30.	125	62.5	7.9057	39.53	47.43
51	25.5	5.0498	20.20	25.25	30.30	126	63.	7.9373	39.69	47.62
52	26.	5.0990	20.40	25.50	30.59	127	63.5	7.9687	39.84	47.81
53	26.5	5.1478	20.59	25.74	30.89	128	64.	8.	40.	48.
54	27.	5.1962	20.78	25.98	31.18	129	64.5	8.0312	40.16	48.19
55	27.5	5.2440	20.98	26.22	31.46	**130**	65.	8.0623	40.31	48.37
56	28.	5.2915	21.17	26.46	31.75	131	65.5	8.0932	40.47	48.56
57	28.5	5.3385	21.35	26.69	32.03	132	66.	8.1240	40.62	48.74
58	29.	5.3852	21.54	26.93	32.31	133	66.5	8.1548	40.77	48.93
59	29.5	5.4314	21.73	27.16	32.59	134	67.	8.1854	40.93	49.11
60	30.	5.4772	21.91	27.39	32.86	135	67.5	8.2158	41.08	49.30
61	30.5	5.5227	22.09	27.61	33.14	136	68.	8.2462	41.23	49.48
62	31.	5.5678	22.27	27.84	33.41	137	68.5	8.2765	41.38	49.66
63	31.5	5.6125	22.45	28.06	33.67	138	69.	8.3066	41.53	49.84
64	32.	5.6569	22.63	28.28	33.94	139	69.5	8.3367	41.68	50.02
65	32.5	5.7009	22.80	28.50	34.21	**140**	70.	8.3666	41.83	50.20
66	33.	5.7446	22.98	28.72	34.47	141	70.5	8.3964	41.98	50.38
67	33.5	5.7879	23.15	28.94	34.73	142	71.	8.4261	42.13	50.56
68	34.	5.8310	23.32	29.15	34.99	143	71.5	8.4558	42.28	50.73
69	34.5	5.8737	23.49	29.37	35.24	144	72.	8.4853	42.43	50.91
70	35.	5.9161	23.66	29.58	35.50	145	72.5	8.5147	42.57	51.09
71	35.5	5.9582	23.83	29.79	35.75	146	73.	8.5440	42.72	51.26
72	36.	6.	24.	30.	36.	147	73.5	8.5732	42.87	51.44
73	36.5	6.0415	24.17	30.21	36.25	148	74.	8.6023	43.01	51.61
74	37.	6.0828	24.33	30.41	36.50	149	74.5	8.6313	43.16	51.79
75	37.5	6.1237	24.49	30.62	36.74	**150**	75.	8.6603	43.30	51.96

THREE PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd.	No. of twisted yarn	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	.33	.5774	2.31	2.89	3.46	76	25.33	5.0332	25.17	30.20
2	.67	.8165	3.27	4.08	4.90	77	25.67	5.0662	25.33	30.40
3	1.	1.	4.	5.	6.	78	26.	5.0990	25.50	30.59
4	1.33	1.1547	4.62	5.77	6.93	79	26.33	5.1316	25.66	30.79
5	1.67	1.2910	5.16	6.45	7.75	**80**	26.67	5.1640	25.82	30.98
6	2.	1.4142	5.66	7.07	8.49	81	27.	5.1962	25.98	31.18
7	2.33	1.5275	6.11	7.64	9.17	82	27.33	5.2281	26.14	31.37
8	2.67	1.6330	6.53	8.16	9.80	83	27.67	5.2599	26.30	31.56
9	3.	1.7321	6.93	8.66	10.39	84	28.	5.2915	26.46	31.75
10	3.33	1.8257	7.30	9.13	10.95	85	28.33	5.3229	26.61	31.94
11	3.67	1.9149	7.66	9.57	11.49	86	28.67	5.3541	26.77	32.12
12	4.	2.	8.	10.	12.	87	29.	5.3852	26.93	32.31
13	4.33	2.0817	8.33	10.41	12.49	88	29.33	5.4160	27.08	32.50
14	4.67	2.1602	8.64	10.80	12.96	89	29.67	5.4467	27.23	32.68
15	5.	2.2361	8.94	11.18	13.42	**90**	30.	5.4772	27.39	32.86
16	5.33	2.3094	9.24	11.55	13.86	91	30.33	5.5076	27.54	33.05
17	5.67	2.3805	9.52	11.90	14.28	92	30.67	5.5377	27.69	33.23
18	6.	2.4495	9.80	12.25	14.70	93	31.	5.5678	27.84	33.41
19	6.33	2.5166	10.07	12.58	15.10	94	31.33	5.5976	27.99	33.59
20	6.67	2.5820	10.33	12.91	15.49	95	31.67	5.6273	28.14	33.76
21	7.	2.6458	10.58	13.23	15.87	96	32.	5.6569	28.28	33.94
22	7.33	2.7080	10.83	13.54	16.25	97	32.33	5.6862	28.43	34.12
23	7.67	2.7689	11.08	13.84	16.61	98	32.67	5.7155	28.58	34.29
24	8.	2.8284	11.31	14.14	16.97	99	33.	5.7446	28.72	34.47
25	8.33	2.8868	11.55	14.43	17.32	**100**	33.33	5.7735	28.87	34.64
26	8.67	2.9439	11.76	14.72	17.66	101	33.67	5.8023	29.01	34.81
27	9.	3.	12.	15.	18.	102	34.	5.8310	29.15	34.99
28	9.33	3.0551	12.22	15.28	18.33	103	34.33	5.8595	29.30	35.16
29	9.67	3.1091	12.44	15.55	18.65	104	34.67	5.8878	29.44	35.33
30	10.	3.1623	12.65	15.81	18.97	105	35.	5.9161	29.58	35.50
31	10.33	3.2145	12.86	16.07	19.29	106	35.33	5.9442	29.72	35.67
32	10.67	3.2659	13.06	16.33	19.60	107	35.67	5.9722	29.86	35.83
33	11.	3.3166	13.27	16.58	19.90	108	36.	6.	30.	36.
34	11.33	3.3665	13.47	16.83	20.20	109	36.33	6.0277	30.14	36.17
35	11.67	3.4157	13.66	17.08	20.49	**110**	36.67	6.0553	30.28	36.33
36	12.	3.4641	13.86	17.32	20.78	111	37.	6.0828	30.41	36.50
37	12.33	3.5119	14.05	17.56	21.07	112	37.33	6.1101	30.55	36.66
38	12.67	3.5590	14.24	17.80	21.35	113	37.67	6.1374	30.69	36.83
39	13.	3.6056	14.42	18.03	21.63	114	38.	6.1644	30.82	36.99
40	13.33	3.6515	14.61	18.26	21.91	115	38.33	6.1914	30.96	37.15
41	13.67	3.6969	14.79	18.48	22.18	116	38.67	6.2183	31.09	37.31
42	14.	3.7417	14.97	18.71	22.45	117	39.	6.2450	31.22	37.47
43	14.33	3.7859	15.14	18.93	22.72	118	39.33	6.2716	31.36	37.63
44	14.67	3.8297	15.32	19.15	22.98	119	39.67	6.2981	31.49	37.79
45	15.	3.8730	15.49	19.36	23.24	**120**	40.	6.3246	31.62	37.95
46	15.33	3.9158	15.66	19.58	23.49	121	40.33	6.3509	31.75	38.11
47	15.67	3.9582	15.83	19.79	23.75	122	40.67	6.3770	31.89	38.26
48	16.	4.	16.	20.	24.	123	41.	6.4031	32.02	38.42
49	16.33	4.0415	16.17	20.21	24.25	124	41.33	6.4291	32.15	38.57
50	16.67	4.0825	16.33	20.41	24.49	125	41.67	6.4550	32.27	38.73
51	17.	4.1231	16.49	20.62	24.74	126	42.	6.4807	32.40	38.88
52	17.33	4.1633	16.65	20.82	24.98	127	42.33	6.5064	32.53	39.04
53	17.67	4.2032	16.81	21.02	25.22	128	42.67	6.5320	32.66	39.19
54	18.	4.2426	16.97	21.21	25.46	129	43.	6.5574	32.79	39.34
55	18.33	4.2817	17.13	21.41	25.69	**130**	43.33	6.5828	32.91	39.50
56	18.67	4.3205	17.28	21.60	25.92	131	43.67	6.6081	33.04	39.65
57	19.	4.3589	17.44	21.79	26.15	132	44.	6.6332	33.17	39.80
58	19.33	4.3970	17.59	21.98	26.38	133	44.33	6.6583	33.29	39.95
59	19.67	4.4347	17.74	22.17	26.61	134	44.67	6.6833	33.42	40.10
60	20.	4.4721	17.89	22.36	26.83	135	45.	6.7082	33.54	40.25
61	20.33	4.5092	18.04	22.55	27.06	136	45.33	6.7330	33.67	40.40
62	20.67	4.5461	18.18	22.73	27.28	137	45.67	6.7577	33.79	40.55
63	21.	4.5826	18.33	22.91	27.50	138	46.	6.7823	33.91	40.69
64	21.33	4.6188	18.48	23.09	27.71	139	46.33	6.8069	34.03	40.84
65	21.67	4.6547	18.62	23.27	27.93	**140**	46.67	6.8313	34.16	40.99
66	22.	4.6904	18.76	23.45	28.14	141	47.	6.8557	34.28	41.13
67	22.33	4.7258	18.90	23.63	28.35	142	47.33	6.8799	34.40	41.28
68	22.67	4.7610	19.04	23.80	28.57	143	47.67	6.9041	34.52	41.42
69	23.	4.7958	19.18	23.98	28.77	144	48.	6.9282	34.64	41.57
70	23.33	4.8305	19.32	24.15	28.98	145	48.33	6.9522	34.76	41.71
71	23.67	4.8648	19.46	24.32	29.19	146	48.67	6.9762	34.88	41.86
72	24.	4.8990	19.60	24.49	29.39	147	49.	7.	35.	42.
73	24.33	4.9329	19.73	24.66	29.60	148	49.33	7.0238	35.12	42.14
74	24.67	4.9666	19.87	24.83	29.80	149	49.67	7.0475	35.24	42.28
75	25.	5.	20.	25.	30.	**150**	50.	7.0711	35.36	42.43

FOUR PLY.

No. of yaru to be twist'd	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd	No of twisted yarn	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	.25	.5	2.	2.5	3.	76	19.	4.3589	21.79	26.15
2	.50	.7071	2.83	3.54	4.24	77	.25	4.3875	21.94	26.32
3	.75	.8660	3.46	4.33	5.20	78	.50	4.4159	22.08	26.50
4	1.	1.	4.	5.	6.	79	.75	4.4441	22.22	26.66
5	.25	1.1180	4.47	5.59	6.71	**80**	20.	4.4721	22.36	26.83
6	.50	1.2247	4.90	6.12	7.35	81	.25	4.5	22.5	27.
7	.75	1.3229	5.29	6.61	7.94	82	.50	4.5277	22.64	27.17
8	2.	1.4142	5.66	7.07	8.49	83	.75	4.5552	22.78	27.33
9	.25	1.5	6.	7.5	9.	84	21.	4.5826	22.91	27.50
10	.50	1.5811	6.32	7.91	9.49	85	.25	4.6098	23.05	27.66
11	.75	1.6583	6.63	8.29	9.95	86	.50	4.6368	23.18	27.82
12	3.	1.7321	6.93	8.66	10.39	87	.75	4.6637	23.32	27.98
13	.25	1.8028	7.21	9.01	10.82	88	22.	4.6904	23.45	28.14
14	.50	1.8708	7.48	9.35	11.22	89	.25	4.7170	23.58	28.30
15	.75	1.9365	7.75	9.68	11.62	**90**	.50	4.7434	23.72	28.46
16	4.	2.	8.	10.	12.	91	.75	4.7697	23.85	28.62
17	.25	2.0616	8.25	10.31	12.37	92	23.	4.7958	23.98	28.77
18	.50	2.1213	8.49	10.61	12.73	93	.25	4.8218	24.11	28.93
19	.75	2.1794	8.72	10.90	13.08	94	.50	4.8477	24.24	29.09
20	5.	2.2361	8.94	11.18	13.42	95	.75	4.8734	24.37	29.24
21	.25	2.2913	9.17	11.40	13.75	96	24.	4.8990	24.49	29.39
22	.50	2.3452	9.38	11.73	14.07	97	.25	4.9244	24.62	29.55
23	.75	2.3979	9.59	11.99	14.39	98	.50	4.9497	24.75	29.70
24	6.	2.4495	9.80	12.25	14.70	99	.75	4.9749	24.87	29.85
25	.25	2.5	10.	12.5	15.	**100**	25.	5.	25.	30.
26	.50	2.5495	10.20	12.75	15.30	101	.25	5.0249	25.12	30.15
27	.75	2.5981	10.39	12.99	15.59	102	.50	5.0498	25.25	30.30
28	7.	2.6458	10.58	13.23	15.87	103	.75	5.0744	25.37	30.45
29	.25	2.6926	10.77	13.46	16.16	104	26.	5.0990	25.50	30.59
30	.50	2.7386	10.95	13.69	16.43	105	.25	5.1235	25.62	30.74
31	.75	2.7839	11.14	13.92	16.70	106	.50	5.1478	25.74	30.89
32	8.	2.8284	11.31	14.14	16.97	107	.75	5.1720	25.86	31.03
33	.25	2.8723	11.49	14.36	17.23	108	27.	5.1962	25.98	31.18
34	.50	2.9155	11.66	14.58	17.49	109	.25	5.2202	26.10	31.32
35	.75	2.9580	11.83	14.79	17.75	**110**	.50	5.2440	26.22	31.46
36	9.	3.	12.	15.	18.	111	.75	5.2678	26.34	31.61
37	.25	3.0414	12.17	15.21	18.25	112	28.	5.2915	26.46	31.75
38	.50	3.0822	12.33	15.41	18.49	113	.25	5.3151	26.58	31.89
39	.75	3.1225	12.49	15.61	18.73	114	.50	5.3385	26.69	32.03
40	10.	3.1623	12.65	15.81	18.97	115	.75	5.3619	26.81	32.17
41	.25	3.2016	12.81	16.01	19.21	116	29.	5.3852	26.93	32.31
42	.50	3.2404	12.96	16.20	19.44	117	.25	5.4083	27.04	32.45
43	.75	3.2787	13.11	16.39	19.67	118	.50	5.4314	27.16	32.59
44	11.	3.3166	13.27	16.58	19.90	119	.75	5.4543	27.27	32.73
45	.25	3.3541	13.42	16.77	20.12	**120**	30.	5.4772	27.39	32.86
46	.50	3.3912	13.56	16.96	20.35	121	.25	5.5	27.5	33.
47	.75	3.4278	13.71	17.14	20.57	122	.50	5.5227	27.61	33.14
48	12.	3.4641	13.86	17.32	20.78	123	.75	5.5453	27.73	33.27
49	.25	3.5	14.	17.5	21.	124	31.	5.5678	27.84	33.41
50	.50	3.5355	14.14	17.68	21.21	125	.25	5.5902	27.95	33.54
51	.75	3.5707	14.28	17.85	21.42	126	.50	5.6125	28.06	33.67
52	13.	3.6056	14.42	18.03	21.63	127	.75	5.6347	28.17	33.81
53	.25	3.6401	14.56	18.20	21.84	128	32.	5.6569	28.28	33.94
54	.50	3.6742	14.70	18.37	22.05	129	.25	5.6789	28.39	34.07
55	.75	3.7081	14.83	18.54	22.25	**130**	.50	5.7009	28.50	34.21
56	14.	3.7417	14.97	18.71	22.45	131	.75	5.7228	28.61	34.34
57	.25	3.7749	15.10	18.87	22.65	132	33.	5.7446	28.72	34.47
58	.50	3.8079	15.23	19.04	22.85	133	.25	5.7663	28.83	34.60
59	.75	3.8406	15.36	19.20	23.04	134	.50	5.7879	28.94	34.73
60	15.	3.8730	15.49	19.37	23.24	135	.75	5.8095	29.05	34.86
61	.25	3.9051	15.62	19.53	23.43	136	34.	5.8310	29.15	34.99
62	.50	3.9370	15.75	19.69	23.62	137	.25	5.8524	29.26	35.11
63	.75	3.9686	15.88	19.84	23.81	138	.50	5.8737	29.37	35.24
64	16.	4.	16.	20.	24.	139	.75	5.8949	29.47	35.37
65	.25	4.0311	16.12	20.16	24.19	**140**	35.	5.9161	29.58	35.50
66	.50	4.0620	16.25	20.31	24.37	141	.25	5.9372	29.69	35.62
67	.75	4.0927	16.37	20.46	24.56	142	.50	5.9582	29.79	35.75
68	17.	4.1231	16.49	20.62	24.74	143	.75	5.9791	29.90	35.87
69	.25	4.1533	16.61	20.77	24.92	144	36.	6.	30.	36.
70	.50	4.1833	16.73	20.92	25.10	145	.25	6.0208	30.10	36.12
71	.75	4.2130	16.85	21.07	25.28	146	.50	6.0415	30.21	36.25
72	18.	4.2426	16.97	21.21	25.46	147	.75	6.0622	30.31	36.37
73	.25	4.2720	17.09	21.36	25.63	148	37.	6.0828	30.41	36.50
74	.50	4.3012	17.20	21.51	25.81	149	.25	6.1033	30.52	36.62
75	.75	4.3301	17.32	21.65	25.98	**150**	.50	6.1237	30.62	36.74

FIVE PLY.

No. of yarn to be twist'd	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist d.	No of twisted yarn	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	**5**	**6**				**5**	**6**
1	.2	.4472	1.79	2.24	2.68	76	15.2	3.8987	19.49	23.39
2	.4	.6325	2.53	3.16	3.79	77	.4	3.9243	19.62	23.55
3	.6	.7746	3.10	3.87	4.65	78	.6	3.9497	19.75	23.70
4	.8	.8944	3.58	4.47	5.37	79	.8	3.9749	19.87	23.85
5	1.	1.	4.	5.	6.	**80**	16.	4.	20.	24.
6	.2	1.0954	4.38	5.48	6.57	81	.2	4.0249	20.12	24.15
7	.4	1.1832	4.73	5.92	7.10	82	.4	4.0497	20.25	24.30
8	.6	1.2649	5.06	6.32	7.59	83	.6	4.0743	20.37	24.45
9	.8	1.3416	5.37	6.71	8.05	84	.8	4.0988	20.49	24.59
10	2.	1.4142	5.66	7.07	8.49	85	17.	4.1231	20.62	24.74
11	.2	1.4832	5.93	7.42	8.90	86	.2	4.1473	20.74	24.88
12	.4	1.5492	6.20	7.75	9.30	87	.4	4.1713	20.86	25.03
13	.6	1.6125	6.45	8.06	9.67	88	.6	4.1952	20.98	25.17
14	.8	1.6733	6.69	8.37	10.04	89	.8	4.2190	21.10	25.31
15	3.	1.7321	6.93	8.66	10.39	**90**	18.	4.2426	21.21	25.46
16	.2	1.7889	7.16	8.95	10.73	91	.2	4.2661	21.33	25.60
17	.4	1.8439	7.38	9.22	11.06	92	.4	4.2895	21.45	25.74
18	.6	1.8974	7.59	9.49	11.38	93	.6	4.3128	21.56	25.88
19	.8	1.9494	7.80	9.75	11.70	94	.8	4.3359	21.68	26.02
20	4.	2.	8.	10.	12.	95	19.	4.3589	21.79	26.15
21	.2	2.0494	8.20	10.25	12.30	96	.2	4.3818	21.91	26.29
22	.4	2.0976	8.39	10.49	12.59	97	.4	4.4045	22.02	26.43
23	.6	2.1448	8.58	10.72	12.87	98	.6	4.4272	22.14	26.56
24	.8	2.1909	8.76	10.95	13.15	99	.8	4.4497	22.25	26.70
25	5.	2.2361	8.94	11.18	13.42	**100**	20.	4.4721	22.36	26.83
26	.2	2.2804	9.12	11.40	13.68	101	.2	4.4944	22.47	26.97
27	.4	2.3238	9.30	11.62	13.94	102	.4	4.5166	22.58	27.10
28	.6	2.3664	9.47	11.83	14.20	103	.6	4.5387	22.69	27.23
29	.8	2.4083	9.63	12.04	14.45	104	.8	4.5607	22.80	27.36
30	6.	2.4495	9.80	12.25	14.70	105	21.	4.5826	22.91	27.50
31	.2	2.4900	9.96	12.45	14.94	106	.2	4.6043	23.02	27.63
32	.4	2.5298	10.12	12.65	15.18	107	.4	4.6260	23.13	27.76
33	.6	2.5690	10.28	12.85	15.41	108	.6	4.6476	23.24	27.89
34	.8	2.6077	10.43	13.04	15.65	109	.8	4.6690	23.35	28.01
35	7.	2.6458	10.58	13.23	15.87	**110**	22.	4.6904	23.45	28.14
36	.2	2.6833	10.73	13.42	16.10	111	.2	4.7117	23.56	28.27
37	.4	2.7203	10.88	13.60	16.32	112	.4	4.7329	23.66	28.40
38	.6	2.7568	11.03	13.78	16.54	113	.6	4.7539	23.77	28.52
39	.8	2.7928	11.17	13.96	16.76	114	.8	4.7749	23.87	28.65
40	8.	2.8284	11.31	14.14	16.97	115	23.	4.7958	23.98	28.77
41	.2	2.8636	11.45	14.32	17.18	116	.2	4.8166	24.08	28.90
42	.4	2.8983	11.59	14.49	17.39	117	.4	4.8374	24.19	29.02
43	.6	2.9326	11.73	14.66	17.60	118	.6	4.8580	24.29	29.15
44	.8	2.9665	11.87	14.83	17.80	119	.8	4.8785	24.39	29.27
45	9.	3.	12.	15.	18.	**120**	24.	4.8990	24.49	29.39
46	.2	3.0332	12.13	15.17	18.20	121	.2	4.9193	24.60	29.52
47	.4	3.0659	12.26	15.33	18.40	122	.4	4.9396	24.70	29.64
48	.6	3.0984	12.39	15.49	18.59	123	.6	4.9598	24.80	29.76
49	.8	3.1305	12.52	15.65	18.78	124	.8	4.9800	24.90	29.88
50	10.	3.1623	12.65	15.81	18.97	125	25.	5.	25.	30.
51	.2	3.1937	12.77	15.97	19.16	126	.2	5.0200	25.10	30.12
52	.4	3.2249	12.90	16.12	19.35	127	.4	5.0398	25.20	30.24
53	.6	3.2558	13.02	16.28	19.53	128	.6	5.0596	25.30	30.36
54	.8	3.2863	13.15	16.43	19.72	129	.8	5.0794	25.40	30.48
55	11.	3.3166	13.27	16.58	19.90	**130**	26.	5.0990	25.50	30.59
56	.2	3.3466	13.39	16.73	20.08	131	.2	5.1186	25.59	30.71
57	.4	3.3764	13.51	16.88	20.26	132	.4	5.1381	25.69	30.83
58	.6	3.4059	13.62	17.03	20.44	133	.6	5.1575	25.79	30.95
59	.8	3.4351	13.74	17.18	20.61	134	.8	5.1769	25.88	31.06
60	12.	3.4641	13.86	17.32	20.78	135	27.	5.1962	25.98	31.18
61	.2	3.4928	13.97	17.46	20.96	136	.2	5.2154	26.08	31.29
62	.4	3.5214	14.09	17.61	21.13	137	.4	5.2345	26.17	31.41
63	.6	3.5496	14.20	17.75	21.30	138	.6	5.2536	26.27	31.52
64	.8	3.5777	14.31	17.89	21.47	139	.8	5.2726	26.36	31.64
65	13.	3.6056	14.42	18.03	21.63	**140**	28.	5.2915	26.46	31.75
66	.2	3.6332	14.53	18.17	21.80	141	.2	5.3104	26.55	31.86
67	.4	3.6606	14.64	18.30	21.96	142	.4	5.3292	26.65	31.97
68	.6	3.6878	14.75	18.44	22.13	143	.6	5.3479	26.74	32.09
69	.8	3.7148	14.86	18.57	22.29	144	.8	5.3666	26.83	32.20
70	14.	3.7417	14.97	18.71	22.45	145	29.	5.3852	26.93	32.31
71	.2	3.7683	15.07	18.84	22.61	146	.2	5.4037	27.02	32.42
72	.4	3.7947	15.18	18.97	22.77	147	.4	5.4222	27.11	32.53
73	.6	3.8210	15.28	19.10	22.93	148	.6	5.4406	27.20	32.64
74	.8	3.8471	15.38	19.24	23.08	149	.8	5.4589	27.29	32.75
75	15.	3.8730	15.49	19.37	23.24	**150**	30.	5.4772	27.39	32.86

SIX PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	.17	.4082	1.63	2.04	2.45	76	12.67	3.5590	17.80	21.35
2	.33	.5774	2.31	2.89	3.46	77	.83	3.5824	17.91	21.49
3	.50	.7071	2.83	3.54	4.24	78	13.	3.6056	18.03	21.63
4	.67	.8165	3.27	4.08	4.90	79	.17	3.6286	18.14	21.77
5	.83	.9129	3.65	4.56	5.48	**80**	.33	3.6515	18.26	21.91
6	1.	1.	4.	5.	6.	81	.50	3.6742	18.37	22.05
7	.17	1.0801	4.32	5.40	6.48	82	.67	3.6969	18.48	22.18
8	.33	1.1547	4.62	5.77	6.93	83	.83	3.7192	18.60	22.32
9	.50	1.2247	4.90	6.12	7.35	84	14.	3.7417	18.71	22.45
10	.67	1.2910	5.16	6.45	7.75	85	.17	3.7639	18.82	22.58
11	.83	1.3540	5.42	6.77	8.12	86	.33	3.7859	18.93	22.72
12	2.	1.4142	5.66	7.07	8.49	87	.50	3.8079	19.04	22.85
13	.17	1.4720	5.89	7.36	8.83	88	.67	3.8297	19.15	22.98
14	.33	1.5275	6.11	7.64	9.17	89	.83	3.8514	19.26	23.11
15	.50	1.5811	6.32	7.91	9.49	**90**	15.	3.8730	19.36	23.24
16	.67	1.6330	6.53	8.16	9.80	91	.17	3.8944	19.47	23.37
17	.83	1.6833	6.73	8.42	10.10	92	.33	3.9158	19.58	23.49
18	3.	1.7321	6.93	8.66	10.39	93	.50	3.9370	19.69	23.62
19	.17	1.7795	7.12	8.90	10.68	94	.67	3.9582	19.79	23.75
20	.33	1.8257	7.30	9.13	10.95	95	.83	3.9791	19.90	23.87
21	.50	1.8708	7.48	9.35	11.22	96	16.	4.	20.	24.
22	.67	1.9149	7.66	9.57	11.49	97	.17	4.0208	20.10	24.12
23	.83	1.9579	7.83	9.79	11.75	98	.33	4.0415	20.21	24.25
24	4.	2.	8.	10.	12.	99	.50	4.0620	20.31	24.37
25	.17	2.0412	8.16	10.21	12.25	**100**	.67	4.0825	20.41	24.49
26	.33	2.0817	8.33	10.41	12.49	101	.83	4.1028	20.51	24.62
27	.50	2.1213	8.49	10.61	12.73	102	17.	4.1231	20.62	24.74
28	.67	2.1602	8.64	10.80	12.96	103	.17	4.1433	20.72	24.86
29	.83	2.1985	8.79	10.99	13.19	104	.33	4.1633	20.82	24.98
30	5.	2.2361	8.94	11.18	13.42	105	.50	4.1833	20.92	25.10
31	.17	2.2730	9.09	11.37	13.64	106	.67	4.2032	21.02	25.22
32	.33	2.3094	9.24	11.55	13.86	107	.83	4.2229	21.11	25.34
33	.50	2.3452	9.38	11.73	14.07	108	18.	4.2426	21.21	25.46
34	.67	2.3805	9.52	11.90	14.28	109	.17	4.2622	21.31	25.57
35	.83	2.4152	9.66	12.08	14.49	**110**	.33	4.2817	21.41	25.69
36	6.	2.4495	9.80	12.25	14.70	111	.50	4.3012	21.51	25.81
37	.17	2.4833	9.93	12.42	14.90	112	.67	4.3205	21.60	25.92
38	.33	2.5166	10.07	12.58	15.10	113	.83	4.3397	21.70	26.04
39	.50	2.5495	10.20	12.75	15.30	114	19.	4.3589	21.79	26.15
40	.67	2.5820	10.53	12.91	15.49	115	.17	4.3780	21.89	26.27
41	.83	2.6141	10.46	13.07	15.68	116	.33	4.3970	21.98	26.38
42	7.	2.6458	10.58	13.23	15.87	117	.50	4.4159	22.08	26.50
43	.17	2.6771	10.71	13.39	16.06	118	.67	4.4347	22.17	26.61
44	.33	2.7080	10.83	13.54	16.25	119	.83	4.4535	22.27	26.72
45	.50	2.7386	10.95	13.69	16.43	**120**	20.	4.4721	22.36	26.83
46	.67	2.7689	11.08	13.84	16.61	121	.17	4.4907	22.45	26.94
47	.83	2.7988	11.20	13.99	16.79	122	.33	4.5092	22.55	27.06
48	8.	2.8284	11.31	14.14	16.97	123	.50	4.5277	22.64	27.17
49	.17	2.8577	11.43	14.29	17.15	124	.67	4.5461	22.73	27.28
50	.33	2.8868	11.55	14.43	17.32	125	.83	4.5644	22.82	27.39
51	.50	2.9155	11.66	14.58	17.49	126	21.	4.5826	22.91	27.50
52	.67	2.9439	11.78	14.72	17.66	127	.17	4.6007	23.00	27.60
53	.83	2.9721	11.89	14.86	17.83	128	.33	4.6188	23.09	27.71
54	9.	3.	12.	15.	18.	129	.50	4.6368	23.18	27.82
55	.17	3.0277	12.11	15.14	18.17	**130**	.67	4.6547	23.27	27.93
56	.33	3.0551	12.22	15.28	18.33	131	.83	4.6726	23.36	28.04
57	.50	3.0822	12.33	15.41	18.49	132	22.	4.6904	23.45	28.14
58	.67	3.1091	12.44	15.55	18.65	133	.17	4.7081	23.54	28.25
59	.83	3.1358	12.54	15.68	18.81	134	.33	4.7258	23.63	28.35
60	10.	3.1623	12.65	15.81	18.97	135	.50	4.7434	23.72	28.46
61	.17	3.1885	12.75	15.94	19.13	136	.67	4.7610	23.80	28.57
62	.33	3.2145	12.86	16.07	19.29	137	.83	4.7784	23.89	28.67
63	.50	3.2404	12.96	16.20	19.44	138	23.	4.7958	23.98	28.77
64	.67	3.2659	13.06	16.33	19.60	139	.17	4.8132	24.07	28.88
65	.83	3.2914	13.17	16.46	19.75	**140**	.33	4.8305	24.15	28.98
66	11.	3.3166	13.27	16.58	19.90	141	.50	4.8477	24.24	29.09
67	.17	3.3417	13.37	16.71	20.05	142	.67	4.8648	24.32	29.19
68	.33	3.3665	13.47	16.83	20.20	143	.83	4.8819	24.41	29.29
69	.50	3.3912	13.56	16.96	20.35	144	24.	4.8990	24.49	29.39
70	.67	3.4157	13.66	17.08	20.49	145	.17	4.9160	24.58	29.50
71	.83	3.4400	13.76	17.20	20.64	146	.33	4.9329	24.66	29.60
72	12.	3.4641	13.86	17.32	20.78	147	.50	4.9497	24.75	29.70
73	.17	3.4881	13.95	17.44	20.93	148	.67	4.9666	24.83	29.80
74	.33	3.5119	14.05	17.56	21.07	149	.83	4.9833	24.92	29.90
75	.50	3.5355	14.14	17.68	21.21	**150**	25.	5.	25.	30.

THE NORTHROP LOOM.

One hundred years ago the Cotton Gin of Eli Whitney startled the Textile world. To-day the Northrop Loom awakens a like interest. We compare this loom with that old time invention as nothing devised in the years between has sufficient relative importance in the art.

Such a statement is not intended to detract from the inventive skill shown in the wonderful improvements that have so reduced the cost of manufacturing yarn and cloth meanwhile. We ourselves have introduced a large proportion of such inventions, and we fully appreciate their importance. When we state that this loom can save one quarter or more of the entire labor expense in cloth manufacture, it is then apparent why rivals are scarce. We have tried to be reasonably conservative during the trial of this device. The present evidence however, leaves no room for doubt, and we have no right to withhold facts from an interested public. We are now assured that our inventions will largely reduce the cost of manufacturing, and that their field is so extensive as to include nearly every style of fabric.

We reduce the element of labor in weaving.

We reduce imperfections in cloth.

We make weaving a more continuous operation.

How is this accomplished?

Those familiar with the ordinary loom know how our improvements produce the above effects. We will try to elaborate the matter for general understanding.

The ordinary loom stops when the filling carried by its shuttle is broken or exhausted. It does not stop when warp threads break, and therefore depends on the constant oversight of its operator. The supply of filling in a shuttle will last, in usual weaving, from one minute to ten, depending on the size of shuttle, fineness of yarn, speed of loom and width of cloth. Warp threads will break with varying regularity according to conditions, averaging at least twenty per loom per day on ordinary goods.

A weaver's duties are, therefore, supplying filling to looms when exhausted, repairing broken warp threads, and constantly watching to see that no loom is stopped for unnecessary length of time, and no broken warp thread allowed to make a defect in the cloth. There are other duties, of course, but they form a small proportion of the whole.

This is the state of affairs we endeavored to improve on. In retracing the state of the art it is found that in plain weaving the same loom mechanism has been used for fifty years. In many mills it would be difficult for a novice to tell looms built thirty years since, from modern looms, the only difference being in design and slight modifications. Fancy looms have undergone great improvement, it is true, and modern plain looms are undoubtedly more efficient and convenient. The principles, however, are the same.

Invention has not necessarily been stifled meanwhile. The patent records show hundreds of attempted improvements. The problem, however, seems to have been too hard or requiring too great outlay in experiments.

Our firm make it their business to introduce improvements in Cotton Machinery. Having seen our Spindles successfully launched, we looked over the field and saw in the loom great possible chance for improvement. We saw that if the filling could be automatically inserted, great saving in labor was possible; and we accordingly selected inventors to work out the problem under our supervision.

This start was prior to 1889, and we have therefore been continuously engaged for over seven years. It may be reasonably stated that the problem was not finally solved until the present time.

It was not success when, in 1889, we had a loom in actual mill operation changing its own filling.

It was not success when, in 1892, we had fifty looms changing filling in the Pacific Mills.

It was not success in 1893 when we had eighty looms on exhibition with improved filling changers, nor yet in 1894 when those looms were equipped with warp stop motions and running with five weavers.

Neither was success secure when in 1895 a mill was started where weavers ran as many as twenty-four looms each, in regular operation.

Success, however, may well seem attained when, with the start of this year 1896, our books show large orders from mills that have tried the loom thoroughly, and from men who have practically investigated the facts learned by actual use.

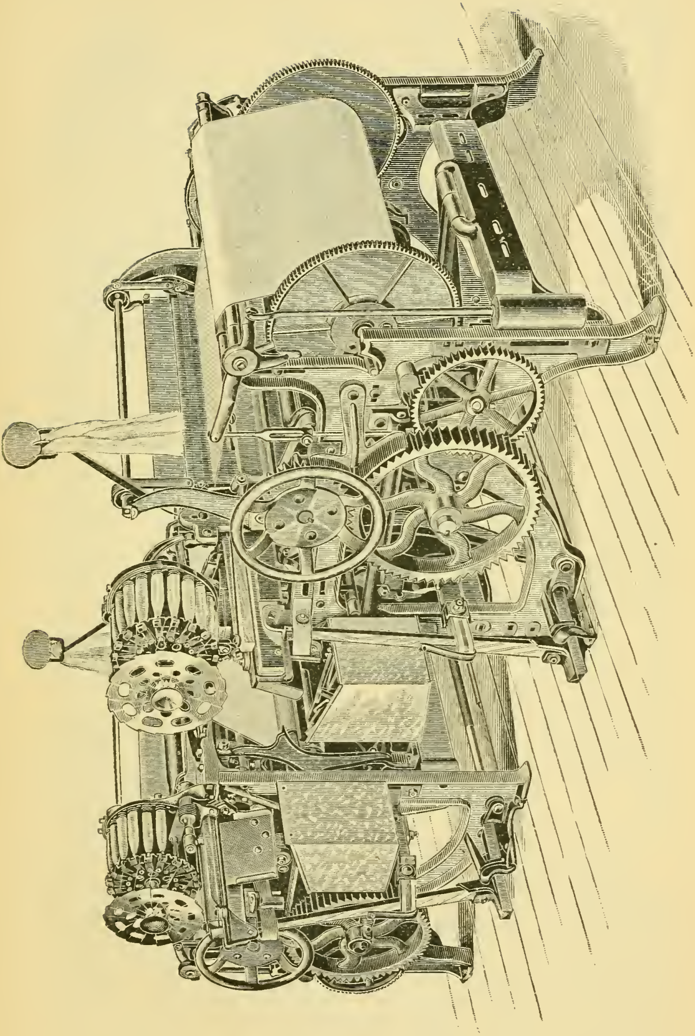
Results cannot be guaranteed in advance.

Theory applied to future results is almost worthless.

Facts are the only true proof, and we now stand on facts.

THE MECHANISM.

The object of our loom in its present form is to automatically supply its filling, and to mechanically prevent faults in the warp. After our seven years experimenting, resulting in over sixty patents, and many inventions not yet secured by patents, we have absolutely practical mechanism that will



Two Northrop Looms.
(Shown facing each other.)

They have Steel Harness Stop Motion, and are of our '94 pattern.

accomplish these results. The devices used for these purposes are as follows:

A Filling Changer involving the following mechanisms:

- A filling fork to detect fault or absence in the filling.
- A hopper to hold an extra supply of filling.
- A transferrer to transfer extra filing from the hopper.
- A peculiar shuttle which will release the old filling carrier and properly receive the new, threading the yarn in its eye automatically.
- A device to receive the spent filling carrier, involving a chute and box.
- A device to protect the apparatus from damage in case the shuttle is not in proper position to receive a new filling supply.
- A thread cutter to sever the thread extending from the hopper to the cloth when fresh filling is inserted.
- A device to stop the loom in case filling is all absent from the hopper, or in case the shuttle fails to thread more than once successively.

The Warp Stop Motions are in several forms, all involving the same idea of stopping the loom in case any individual thread breaks or becomes unduly slack. They include drop wires, detectors and heddles, acting as follows:

In the Harness.
Back of the Harness.
Back of the Lease Rods.
In front of the Harness.
On the Lay.
In the Reed.

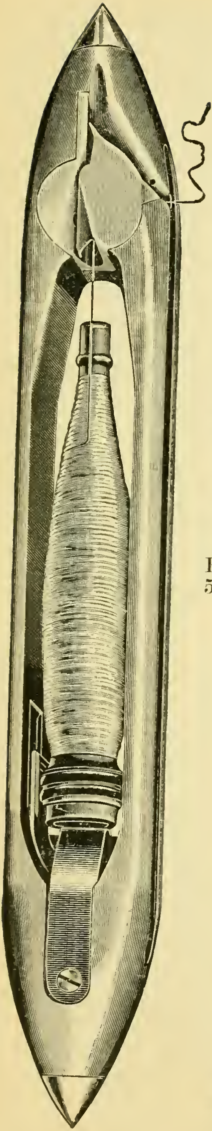
Those that we have in large use are those in the Harness and immediately back or in front of them.

THE OPERATION.

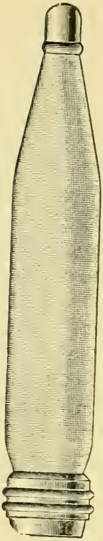
The detail of operation of our loom is as follows:

The filling is spun on the regular frame or mule. When frame filling is used the bobbins have a peculiarly shaped base around which are sprung two heavy steel rings. This in no way interferes with spinning, and indeed very appreciably strengthens the bobbin. The weaver takes these bobbins and places them in the notches of a circular hopper attached to the loom breast beam, winding the end of filling around a stud. When cops are used they are first skewered on a spindle having a base similar to the bobbin base.

The shuttle in the loom is entirely different from that used with the common loom. It is open from top to bottom. The bobbin or cop spindle is held by grooved springs acting on the rings before mentioned. At the eye end is a very ingenious arrangement, adapted to engage and confine the thread.



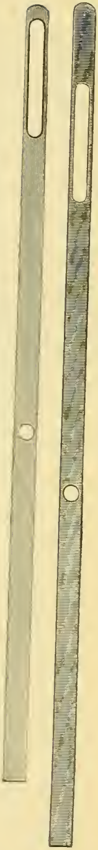
Northrop Loom Shuttle in latest form.



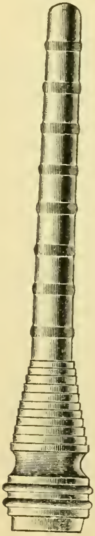
Full Bobbin, 5½ traverse.

7½ inch traverse Bobbin.

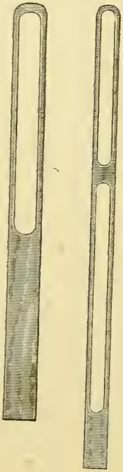
Cop Skewer.



Steel Heddles for use with Harness Warp Stop Motion.



Empty Bobbin, 5½ traverse.



Drop Wires for use with Twine Harness Stop Motion.

When the filling breaks or is exhausted in the shuttle, the filling fork detects it. When the fork is not raised, the usual devices, instead of stopping the loom, turn a rod extending under the breast beam. This rod, through a simple connection, raises a notched dog, attached to a pivoted hammer, which in the hopper is positioned above the lowest bobbin. This dog when raised comes in the path of a bunter on the lay, which on the next forward movement pushes the dog, turning the hammer or transferrer, and forcing the bobbin out of the hopper. With the lay thus forward, the shuttle is directly under this bobbin. Through proper guidance, therefore, this bobbin from the hopper enters the shuttle and pushes the spent one out. The latter rolls down an incline into a large metal box.

When the lay turns back, the shuttle is thrown; and the thread, which has one end attached to the bobbin, and the other to the hopper stud, is guided into the shuttle slot simply by reason of its position. This slot is so devised that the thread having entered cannot jump out again.

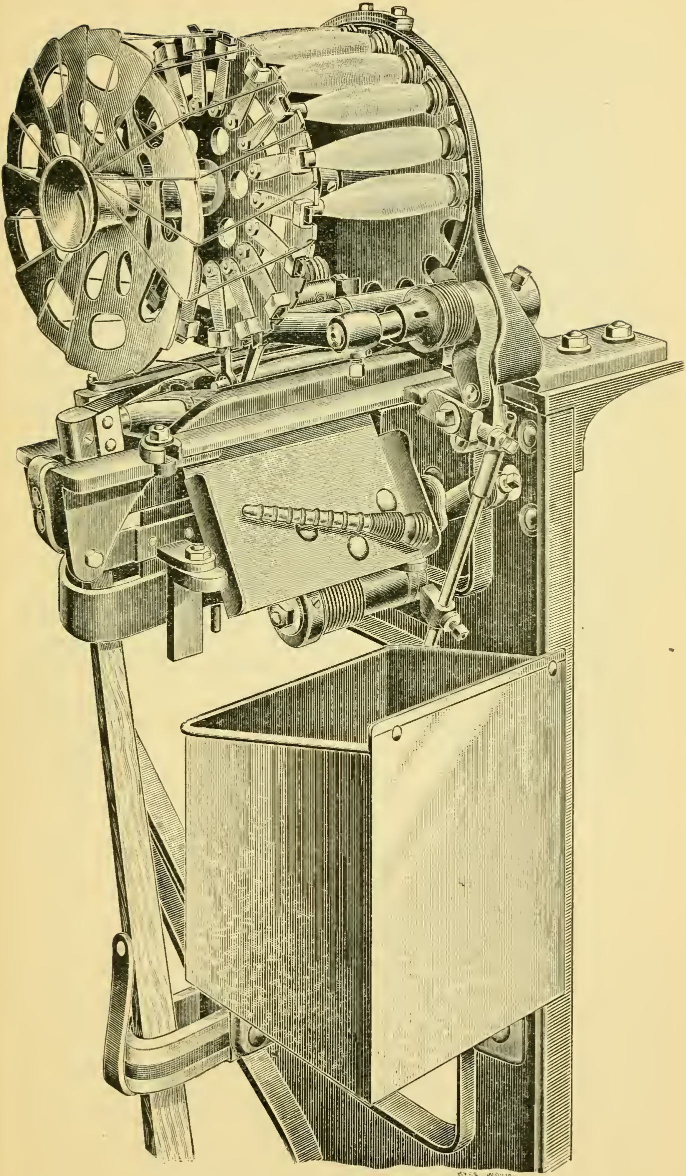
The rod that turns to make the hopper active also moves a device called a "position-detector," which reaches in front of the shuttle box on the lay, and detects whether the shuttle has rebounded excessively or has not reached "home" properly. In such case the hopper will not act and no damage will ensue.

The filling fork has a cam slide so shaped as to act and stop the loom by unshipping the shipper-handle in case the fork is called into action several successive times. This ensures the stopping of the loom in case the hopper is empty, the shuttle clogged, or the pick not set right.

In order to sever the thread attached to the hopper stud, the temple has a circular saw fastened to its roll, which engages this thread after its position has been determined by means of a notch in the Temple.

The hopper rotates through the action of a coiled spring, which is wound up automatically every time a bobbin is ejected. When a bobbin is transferred, it turns another into position. Should there be bobbins misplaced so as to leave blank spaces, it will make no difference.

Our warp stop motions consist of flat tempered steel drop wires, through which the warp is drawn. When the warp is broken they drop and interfere with a vibrator controlling the shipper handle. In our steel harness motion, these drop wires constitute the heddles, and are strung on bars by slots longer than the width of the bar. As a harness this form has special advantages. It automatically spaces itself, requiring no speial sets for change of goods. It will outwear the cotton harness probably ten to one. There is no varnishing. They give the warp threads more room, as they are thinner than the cot-


KYES WOODBURY CO.

DETAIL OF HOPPER MECHANISM.
(other parts of loom erased.)

Shows empty bobbin falling into box while fresh bobbin is being inserted.

ton or twisted wire heddle. No extra drawing in is necessary. We consider our flat heddle the best possible form for harness irrespective of its use as a stop motion.

Our drop wires in front and back of the harness allow the use of the usual twine harness. They cost slightly more for drawing in. They are in use on several thousand looms, giving good satisfaction.

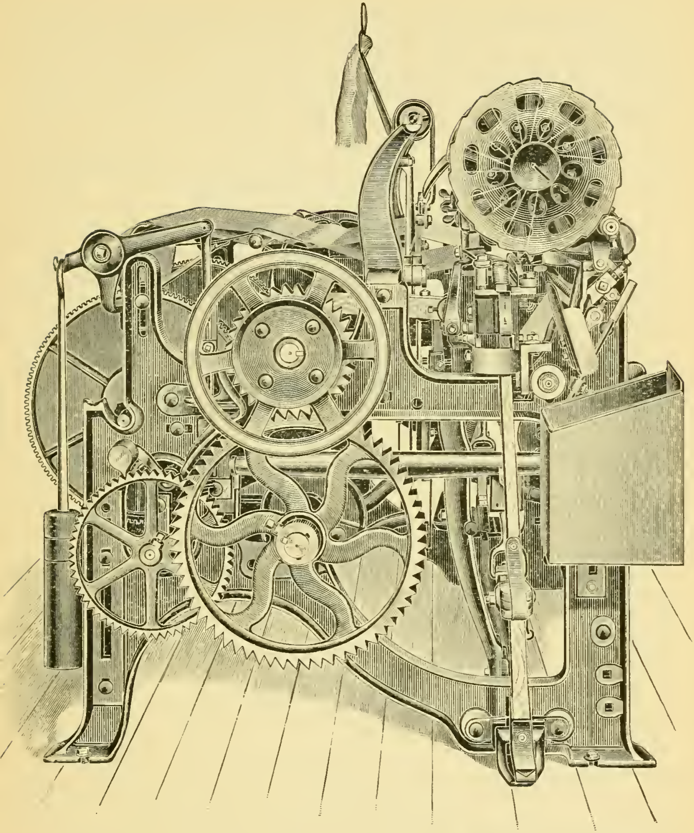
A practical man must consider one feature of a new machine with careful attention. Its complications must not defeat its adaptability. The Northrop loom certainly introduces additional mechanism. This does not add appreciably to the fixer's work, however, as once adjusted they need little attention. By running one shuttle continuously the labor of setting the pick is largely eliminated, and all know how much time is required for this operation in the usual loom room.

We are often asked about wear and repairs. It only needs to be pointed out that these operations take place only about once in five minutes. The other parts of the loom operate from perhaps one hundred to two hundred times a minute. As the ordinary loom wears twenty years at least, the filling changer parts should by comparison wear from ten to twenty thousand years. We will not guarantee them for that period, however.

Taking the rest of the loom in connection with our devices, we have not tried to re-invent except where absolutely necessary. We have certainly found room for improvement, but have not desired to confuse manufacturers with more new schemes than the occasion called for. A loom is a very curious machine in its simplest form, and certain of its motions have that sacred traditional right that one is bound to respect. It will be noticed that our attempts in this field are in the direction of adding additional mechanism rather than changing the parts already there.

On goods where it is necessary to find and match the pick, the usual filling changer will not apply as it is not sure to lay the new filling in the empty shed, and also cannot remedy the fault where part of a thread is left in a shed by the exhausted supply. For such looms our warp stop motion is applicable, and we are also developing an idea of Mr. Geo Otis Draper for a mechanism to detect when the filling is nearly gone, and put in a new supply before the running filling is exhausted. The device is called a "Feeler" as it actually tells by touch when to act.

This has worked successfully on single looms, but we have been too crowded with regular work to get it into marketable shape as yet.



END VIEW OF '94 LOOM.
Steel Harness Stop Motion.

THE INVENTIONS.

The filling changer and co-operating devices are the result of seven years continuous invention on the part of James H. Northrop, for whom the loom is named. The experiments have been under the constant supervision of Gen. Draper and Geo. Otis Draper.

The filling changer is made effective by combination with the warp stop motion, an idea originating with Gen. Draper, whose patents cover this combination. Further development of this second device resulted from inventions of C. F. Roper, and our present forms are inventions of Gen. Draper, Roper and Northrop.

The Shuttle has been developed from inventions of Northrop, Geo. Otis Draper, J. W. Keeley and E. S. Stimpson. Northrop alone has invented over one hundred forms. The present temple thread cutter is the invention of E. S. and W. I. Stimpson.

The Feeler was first developed from Geo. Otis Draper's patent, but has been since modified and improved by Northrop.

THE ADVANTAGES.

To appreciate what these inventions accomplish it is necessary to compare methods. The Northrop loom allows the weaver to supply filling when convenient, instead of every few minutes. The operation of putting a bobbin in a hopper and winding its end around a stud takes only two operations. The common loom requires seven, as follows: Taking the shuttle out, putting in another, starting the loom, taking the empty bobbin or cop tube out of the discarded shuttle, putting in a new bobbin or cop, sucking the thread through the eye, and putting the shuttle in a holder. The chief difference is, however, that with the Northrop loom fourteen, or less, bobbins or cops can be put in while the weaver stands in one place, while with the common loom fourteen trips to the loom are necessary. This doing away with sucking of filling is a very important point from a humanitarian standpoint, as it prevents injuring the lungs through the cotton fibre inhaled. When it is realized that this act is performed about two hundred thousand times per year by each operative, it is no cause for wonder that weavers as a class are proverbially short-lived and consumptive.

Taking the warp into account, when a warp thread breaks on the common loom, it weaves on as usual, making an unsightly defect in the cloth. The weaver is probably busy at another loom, and cannot attend to it. On many goods it is the weaver's custom to allow this thread to run until another or several on the same loom break, or until the loom stops for filling, so as not to have to stop the loom for each thread. Often a thread thus left broken tangles others, making an overshot, necessitating a pickout. This takes several minutes of the weaver's time, during which other looms stop or run the chance of making more poor cloth. A broken thread makes a defect unless instantaneously detected. A warp stop motion is the only possible means by which to ensure quick detection.

The Northrop loom introduces a radical change. The loom does not stop at all for filling, unless its hopper is wholly exhausted. These hoppers carry fourteen bobbins or cops, and the weavers do not let them run out in practice, as they can fill them while the loom is running. It stops instantly for a warp break, preventing any poor cloth, or chance for overshots or pickouts. Instead of stopping 120 times per day or more, it stops but about twenty. This makes the cloth much better, as every time a loom stops there is a liability for a thin place. The loom is also saved much wear and tear, as stopping and starting is detrimental to many moving parts. The great important saving, however, comes from the reduction of the weaver's duties, and the consequent increase in the number of looms tended. This has been found to result in more than doubling the weaver's capacity.

The mill that buys these looms will therefore need less than half the usual force of weavers. As it is a new machine, the help must be given time to learn before expecting the full result.

As weavers are paid by piece work, it is evident that with a great decrease in the labor of producing a cut of cloth must come a proportionate decrease in price paid for weaving the same. There is no reason why weavers should not make more pay at one-half the old price per cut, having lighter duties, practical elimination of weavers' fines, and no sucking-in of filling.

To the manufacturer this means one-half the weaver's cost, or probably one-quarter the entire labor cost in the mill. It is doubtful if all the mill improvements in the last twenty years added together can equal such a saving. In addition, the cloth will be of a much higher standard, with less seconds, on account of the warp stop motion. An increase in production is possible as the looms can be run over-time after the weavers leave at noon and night, gaining at least 10 per cent., if managed properly. The reduction in the number of operatives necessary is quite a point where help or tenements are scarce, —and weavers are usually scarce compared to other help. Many general expense items can be reduced with the reduction of laborers. All these advantages are possible, and the only problem left to the manufacturer is to figure how long he can afford to run his old looms. With a new mill there is no possible question, unless the style of goods demands modifications in the present mechanism not yet designed or invented.

-The wages paid in Cotton Mills in the United States in 1890 amounted to about $89,000,000. A certain proportion of these wages is in yarn and thread mills where looms are not used. At the present day, however, there has been such an increase in the industry that it is safe to figure that there is $80,000,000 paid annually in mills that can use this loom. Weaving takes fully half the wages, and if this loom can save half the weavers' wages, it means $20,000,000 annual saving in this country alone.

We do not absolutely claim that this loom will always save fifty per cent. in weavers' wages. We find, however, that weavers can tend more than double the old number of looms, even with present limited use. Weavers have gone from 4 to 16 looms on certain forty-inch goods, from 6 to 14 on others and from 8 to 24 on print cloth. The Queen City Mill has averaged over 16 looms per weaver for months, while in the usual print cloth mill the average is from 6 to 7 looms. The question of pay has been settled at the Queen City mill, by paying weavers one-half Fall River prices on the same goods. The result is that weavers on 20 and 24 looms make wages never before known to print weavers. In the South, where labor rates are less, our looms are weaving print cloth cheaper than at the Queen City, still allowing weavers higher wages than in neighboring mills. It must be understood that this great increase in number of looms tended in no way lessens the product *per loom.* In fact the production per loom is usually greater with our loom. In many cases weavers on our looms are given day pay till they get used to them. It takes old weavers some time to un-learn former habits. Watching the loom is no longer necessary. The new duties are much more regular and are less exhausting and irritating. As to disadvantages, we will admit that on account of the novelty, they require more fixers and more repairs. They also cost far more than the common loom.

The question to be considered by the mill management then, is, whether, all things considered, our looms will pay at the price asked for them.

We sell a print cloth loom for about $80 more than a common loom costs. This $80 covers the extra costs of our devices, the expense of introduction, and the royalty to the company owning the patents.

THE EARNINGS.

Print weavers on 8 looms at 18 cts. per cut, would earn close to $9 per week, or about $450 per year. Paying 9 cents per cut on 16 Northrop looms would save $28 per loom per year. Allowing for every possible extra at the most inflated estimates, it would still be over $20 per loom per year, in fact probably over $25. Calling it the low figure to avoid quibbling, and we still show 25 per cent. profit, on the extra $80 represented by our devices. Paying at the same rate on 20 Northrop looms would save $33.50, and on 24 Northrop looms the saving would be $37.25. These figures are somewhat theoretical, as in practice the weaver should have a chance to make more pay when taking 20 or 24 looms. In any event, however, it makes an estimate of $20 per loom after deducting extras, appear strongly conservative.

Our warp stop motions on gingham looms have pushed weavers from 4 to 6 looms. With wages on same scale as print weavers, the saving per loom per year should be $37.50 per loom per year.

On certain goods weavers have gone from 4 to 16 looms. Figuring as above the saving should be $84 per loom per year.

In silk, worsted and woolen weaving, weavers earn high wages tending only one or two looms. The use of the Northrop loom on these goods may eventually save several hundred dollars per loom, per year, or pay for the device in a few weeks use.

It will be noticed that the saving increases in proportion as the original basis of common looms tended, lessens. Thus the Gingham loom saves by simple use of stop motion as much or more than the Print loom with stop motion and filling changer. By introducing this loom on Prints, we took the least favorable problem.

THE PRICES.

Many false impressions about the price of our loom have been current. Some mills have hesitated, having heard the price of our 40 inch loom and believing that applied as well to 28 inch looms. We charge on an ascending scale as the loom widens. We have reduced our prices on several extras from those first quoted, and believe we now have a fair standard price that will practically remain unchanged. If interested, write for quotations.

The casual observer may think our profits on these devices high. The Northrop Loom Co., however, up to the present day, has neither made nor declared a dividend. It expects ultimately to clear a profit of about $25 per loom. No one is justified in assuming great risk without a chance for more than ordinary profit. To show the risk we will quote from our records.

The expense of this venture to date has involved an actual cash sum of $185,000 paid for inventions and experiments.

The time and general expenses, not charged to that account, involve at conservative estimate $150,000 more. Our corporations have had to enlarge and refit with new machinery at an expense of over $150,000. They have had to carry looms, parts and extra stock, at times worth $300,000. Patterns, legal expenses, and stock taken in new mills that use the loom, carry the total investment necessary to introduce this invention up to $1,000,000.

Had the loom proved a failure, a large part of that sum would be lost. Our experiments would have gone for naught, our time be lost, our patents worthless, our looms and parts be only worth their weight as metal, or be changed over into common looms at great loss, our special tools and patterns be worthless, and our buildings be empty. In a patent business the profit from successful ideas must pay for all the valueless experiments, and must also be sufficient to provide against expense and possible damages arising from legal onslaughts, whose success would wipe away profit and capital as well. The fact that no other firm has attempted a business of exclusive introduction of patented cotton machinery, shows that others do not care to assume these chances. Patents do not run forever, and there is no way to prevent competition with other new inventions. Had some other loom appeared better than ours and not infringing our patents, we might have sympathy from our friends but nothing would repay the loss.

THE PATENTS.

As to this question of possible infringement, we may as well state our claims. On Jan. 1st, 1896, we owned or controlled patents as follows·

On Shuttle Changers Six, Including
- 2 patents to James H. Northrop.
- 1 patent to Alonzo E. Rhoades.
- 3 patents to John C. Brooks.

On filling Changers Twelve, Including
- 7 patents to James H. Northrop.
- 2 patents to Wm. F. Draper.
- 1 patent to W. F. D. & J. H. N.
- 1 patent to Geo. Otis Draper.
- 1 patent to F. M. Day.

On Warp Stop Motions Seventeen, Including
- 3 patents to Wm. F. Draper.
- 3 patents to Charles F. Roper.
- 1 patent to James H. Northrop.
- 8 patents to Oberlin Smith.
- 1 patent to Edward Smith.
- 1 patent to John C. Brooks.

On Shuttles Ten, Including
- 5 patents to James H. Northrop.
- 2 patents to Geo. Otis Draper.
- 1 patent to John W. Keeley.
- 1 patent to H. W. Owen.
- 1 patent to John C. Brooks.

On Bobbins and Cop Spindles Four, Including
- 2 patents to Luther C. Baldwin.
- 2 patents to James H. Northrop.

On Thread Cutters Three Including

1 patent to W. F. D. and Daniel Durkin.
1 patent to W. F. D., E. S. Stimpson and J. H. N.
1 patent to James H. Northrop.

On Other Parts of Looms

12 patents to various parties.

Sixty patents in all (several of above-mentioned twice, as they cover more than one device.)

We also have patent applications, some of which are already allowed, covering other forms of filling changer, warp stop motion, shuttles, shuttle changer and thread cutters.

All of our most important devices are also patented in Foreign Countries.

We are confident that our patents cover the only practical methods of changing shuttles, cover broadly the essential features of changing filling in shuttles, cover the only practical warp stop motions adapted for general weaving, and also all the minor elements and necessary supplies in the way of bobbins, shuttles, thread cutters, etc.

It is incontestably true that we are the first to introduce and sell practical filling changing looms, and practical warp stop motions for general weaving.

Should any one endeavor to evade the 60 patents we have mentioned, and their aggregate of 417 claims, they must also take into account the patents already applied for, and the records of experiments by which we can apply for several hundred more if necessary. We do not fear attempted proof of prior use, as we have had every former experiment investigated and written up, even having a special agent visit foreign countries in the search. We will defend our rights to the last limit in the courts, and our legal experience, extending over a quarter of a century with continuous law suits, gives us some prominence in this field.

IN GENERAL.

Many mills are hesitating, thinking it a wise policy to delay trial until we have further improvements. The folly of this course is plain. We believe our loom at present will save a mill, under proper management, $20 per year per loom and upwards. A year's delay, therefore, practically adds $20 or more to the loom price; or reversing, if a mill is a year in advance it saves $20 or more on the loom price. No improvement that we are likely to introduce can approach this sum, the only posible changes being in minor details.

Other mills are frightened at reports of large repair items. With a new machine we naturally had to learn from experience. Loom fixers have also had to start fresh, and errors are but natural under the circumstances. We have already found many places where changes were necessary, and we have replaced many parts on looms already sold without charge to the mills. It can readily be understood that there are many ready to raise their hands in horror whenever they hear of a nut loosening or a casting breaking. The common loom is not yet faultless in this respect, however, and we do not yet claim absolute mechanical perfection for its competitor. We are ready to remedy any unnecessary breakage by change of patterns, and we are not in the habit of making others stand the expense of our experiments.

The looms ordered from now on will have the benefit of our experience in starting up several thousand looms. So far as we know at present, every mechanical defect found in our first loom has been remedied. It is not fair to judge our present products by comparison with our first out-put.

We are often asked what goods these looms will weave. We think they will ultimately weave practically all goods. At present we have sold looms for two harness work with one shuttle. We are getting patterns ready for a loom to weave up to five and six harness, and there is no reason why they can not weave such goods. In fact, three and four harness motions have been used on our present loom to a limited extent. Our two harness looms are weaving prints, lawns, and coarse and fine sheetings. Our warp stop motions are being extensively used on gingham looms with good results. The filling changer is not yet adapted to looms with more than one shuttle.

While our first looms sold were for bobbin filling, we have lately run a set of looms with cops for several months with satisfactory results, and we are taking orders for cop looms.

Another question demands whether this loom will not cause trouble in the labor market by throwing help out of work. It is evident that were all the old looms to be replaced to-morrow by these new looms, half the weavers would lose their jobs. Such a transition, however, is impossible. With the most favorable conditions it will take probably twenty years to replace the old looms, considering the demands from new mills that must also be met. As the cotton industry increases at a strong ratio naturally, such a gradual change as this will hardly be noticed among the weaving class. They will notice the relief from sucking filling, however, and should be gratified at the chance to make higher wages. The introduction of high speed spindles has theoretically reduced the necessity for spinners nearly fifty per cent., as spinners tend as many high speed spindles as those of the slower type. No one ever noticed any effect from this diminished need, however, ring-spinners being very scarce at the present day.

The need of labor saving machinery was never so marked as at present. Cotton manufacturers in this country have been reasonably protected by tariffs in the past, but they have never before had to meet the competition at present threatened. The successful operation of the new mills in Japan, India and China points to an alarming cheapening in future cloth production. The only way in which we can meet labor costs of eight to twelve cents per day, is by the use of machines in which the labor is a minor feature.

To Recapitulate.

We consider the new loom will eventually accomplish the following results:—

Save one-half or more of the labor cost of weaving, using less operatives, which involves less labor to hire, to pay off, to find or build tenements for, to supervise.

Make far better goods, involving less seconds, less weavers' fines, less trouble inspecting.

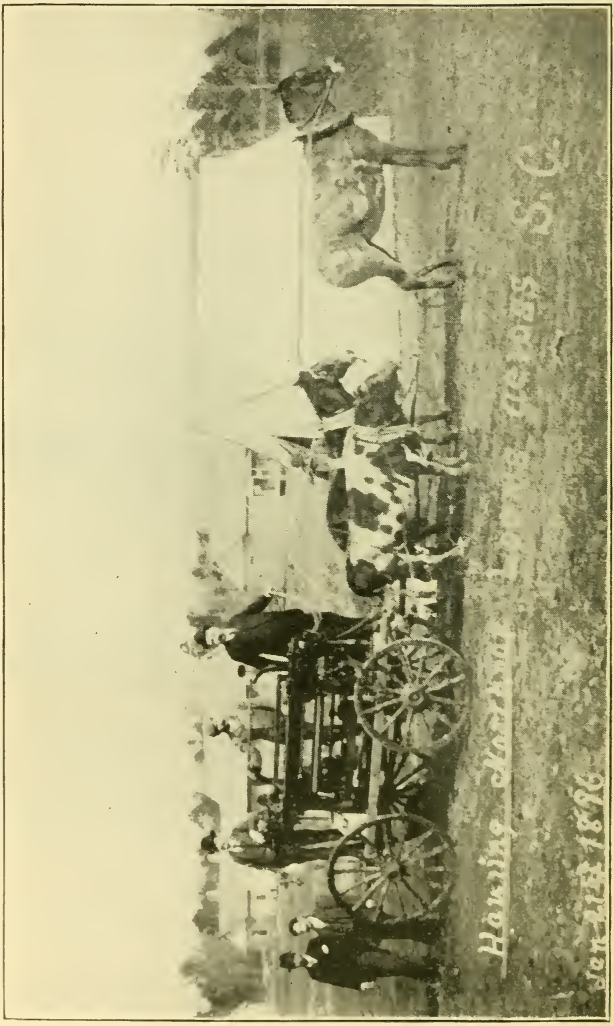
Produce more cloth per loom, saving interest on plant, floor space, general expense.

Easier work for operatives on account of less operations to learn, simpler work to attend them, no sucking filling necessary.

One shuttle run continuously, involving less stopping and wearing of the loom.

On the next page we show a cut taken from a photograph sent us by a friend in the South. It would have made an excellent illustration for a calendar, but came rather late for that purpose.

On page 167 there is an error which we call attention to as follows: The long bobbin is called "7 1-2 inch traverse." It should be 6 1-2 inch, and it can also take 6 3-4 at an extreme. The form was already printed, and we did not care to delay for correction.


Hauling Northrop Looms across S.C.
Jan 21st 1896

Extremes Meet.

LIST OF SALES TO JAN. 1, 1896.

Name of Mill.	No. looms ordered.	Number delivered.	Number Running.
Queen City Cotton Co.,	792	792	792
Pacific Mills,	100	100	100
Merrimack Mfg. Co.,	100	100	100
Tucapau Mill,	320	320	320
Amory Mfg. Co.,	100	50	50
Lawrence Mfg. Co.,	216	216	216
Grosvenor Dale Co.,	335	335	335
Social Mfg. Co.,	196	196	196
Cocheco Co.,	100	100	
Pelzer Mfg. Co.,	1000	1000	
Lockhart Co.,	800	600	
Gaffney Mfg. Co.,	1040		
West Boylston Mfg. Co.,	100		
Albion Co.,	100		
Jas. L. Gary,	100		
R. & H. Adams,	20		
Wilmington Cotton Co.,	60		
Stark Mills,	192		
Mass. Cotton Mills,	100		
Lancaster Mills,	100		
Aurora Cotton Co.,	96		
Lonsdale Co.,	12		
Manville Co.,	24		
Meridian Cotton Mills,	48		
Newmarket Mfg., Co.,	100		
Other small lots,	14	9	9
	6165	3818	2118

JAN. 1 TO MARCH 1.

Mass. Cotton Mills		100	16
Pelzer Mfg Co.,			106
Lockhart Co.,			120
Gaffney Mfg. Co.,		680	12
Lonsdale Co.,		12	12
Chicopee Mfg. Co.,	180		
Tremont & Suffolk,	320		
Spartan Mills,	1280		
New mill not named,	1000		
Lyman Mills,	24		
Dwight Mfg. Co.,	16		
Henrietta Mills,	100		
	9085	4610	2384

1459 looms in the above lot represent second orders given after trial, and 3,752 looms were ordered before mill use had proved their utility. The other orders came after thorough investigation. Had we included conditional orders that we expect to fill in the above list, it would stand 3000 higher.

The Amoskeag Co. are applying our warp stop-motion to their gingham looms, having 600 already running. Other gingham mills have also ordered sample lots. Many thousand looms have also been sold by other builders designed to take our devices later on. We were obliged to disappoint many mills that wanted our looms, but could not get them in time.

We only commenced to deliver looms last Spring. To start in on a new field and deliver 4,600 in less than a year, is no small undertaking, involving as it does turning 2300 tons of metal into machinery. With our enlarged plant we expect to turn out 10,000 looms per year in future, if not 12,000.

At the present date, (March, 1896,) we are the only firm licensed by the Northrop Loom Co. to sell their devices. Other builders of looms have arranged their patterns with the idea of applying our mechanism later on. We have thought it poor policy to allow general introduction by many builders before the devices were fully developed and fully tested.

THE LOOM.

As to the loom itself, we found our devices could not be well applied to old looms, and we consequently had a special loom designed for our purposes. We resolved to spare no expense, and hired a loom expert with instructions to copy the best points of all modern looms. The result has been a design that has proved very satisfactory on work for which it was adapted. We have since made necessary changes for wider goods, and are also preparing to make looms for twill weaves, etc.

The test of use found many places where improvement was possible. We have adopted every suggestion that appeared a real improvement. We could not adopt every individual idea. as many good weavers differ widely in their views, some advocating notions that clash with absolutely opposite opinions.

We have three styles of looms, as follows:

THE '94 LOOM,

which is in present use at the Queen City, Pacific, Merrimack, Tucapau, Grosvenor-Dale, Social, Lawrence, Lockhart, Pelzer and Gaffney mills, also several others in small lots. This is an iron frame loom, shown in our regular cuts and designed originally for light weaves limited in width by the given name size of the loom. It is the heaviest loom built of its class, is furnished with Friction Shepard, or improved Bartlett let off, large or small roll take

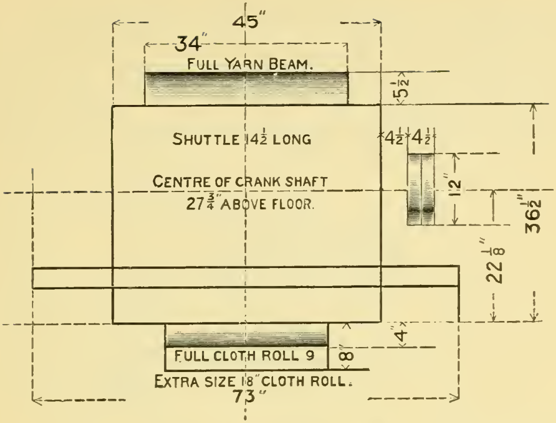


DIAGRAM OF '94 LOOM.

up, plain rocker on pick motion, any warp stop motion. It has special pattern gears and special beam clamp.

This loom will not be furnished hereafter, except to duplicate lots now in use, or on special order.

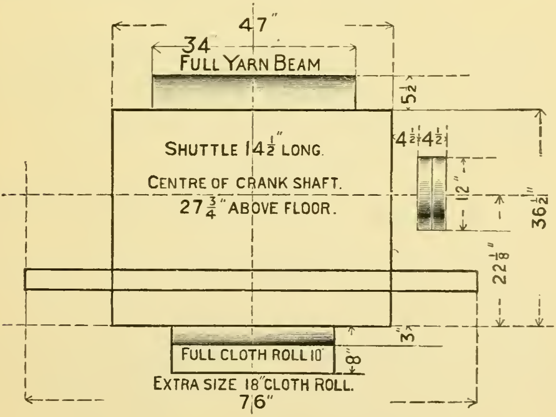


DIAGRAM OF '95 LOOM.

(Note the difference in width, length of lay and small cloth roll space.)

THE '95 LOOM,

(none delivered yet—March, '96), is similar to the '94 pattern, except that it has two inches more width to the frame, and three inches more length to the lay. This allows a longer shuttle box, which good weavers think advisable. This loom will also have a new designed cut motion for winding small roll of cloth, new pattern lay swords, thicker lay, new style take up (every pick) new fork, Stearns rocker, any stop motion. This loom can also be made to have all parts, except pulleys, one hand, same as '96 pattern.

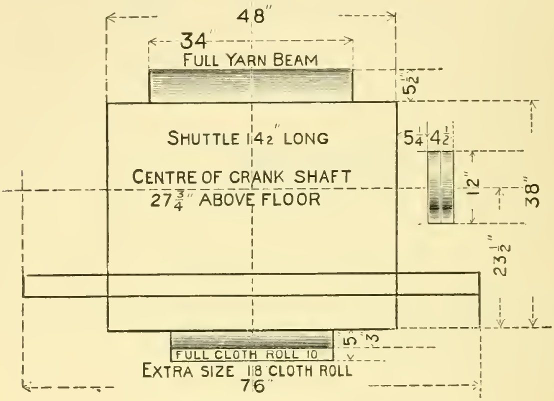


DIAGRAM OF '96 LOOM.

(Note that width is one inch more in frame than '95 loom, but no different in width of lay. Sides are thicker than in '95 loom, which makes the difference. Note also that large cloth roll prejects less than in the '94 and '95 patterns.)

THE '96 LOOM

is being developed especially for heavy weaves and up to six harness. It has more weight, stronger lay, new designs throughout, and a very important feature evolved from ideas of Eben S. Draper, Geo. Otis Draper and Mr. Northrop, by which all the parts are made of one hand. avoiding having rights and lefts, and helping the weaver by always having the most covenient hopper to fill, and the shipper handle always at one side. The looms are set just as at present in the mill, as the pulleys are reversible and the shipping mechanism will act for either end. This change helps the mill by making the repair stock necessary much less in number of parts, and the looms are much handier for fixers and weavers.

On loom orders in future the following features will be followed, unless special orders are given to the contrary:

All looms will have iron frame. back binder, wooden race plate, adjustable reed flighter, wooden binder, side dagger. every pick take up, Stearns rocker, split harness cams, wooden crank arms, beam clamps, tight and loose pulleys.

SPECIFICATION FOR NORTHROP LOOMS.

We give our specification questions with full detailed information as follows:

Size of loom.

Number of looms of above size.

Number Right Hand.

Number Left Hand.

Kind of cloth to be woven.

Width.

Sley.

Number of Picks to inch.

Number of threads in warp.

Number of warp yarn.

Number of filling yarn.

Is filling on Bobbins or Cops.

Necessary to send sample cop, or bobbin and spindle. In case of a new mill give size of cop or filling bobbin intended to be used, and name the make of spindle and diameter of ring when frame filling is to be spun. Our regular sizes of bobbin take 5½ and 6½ inch traverse. Our regular cop size is 5½ traverse; 6½ traverse needs a large size hopper, and lay that is 2½ inches longer.

What let off is required.

We furnish Shepard, Bartlett, Friction, or Bartlett and Friction combined.

What take up is required.

We furnish take up for both small and large roll. Small roll winds up to 10 inches, and large roll to 18 inches. Both kinds take up at every pick, and are arranged to prevent thin places when filling is changed.

Shall take up roll have

Sand Paper, Steel Fillet or Perforated Tin.

How many harnesses are to be used?

What Warp Stop Motion is required?

Steel Harness, or Drop Wire for use with Cotton Harness.

How many Drop Wires or Steel Heddles are required?

If drop wire stop motion is to be used there will be one drop needed for every two warp threads in a two harness loom. If steel harness stop motion is to be used there will be one heddle for each thread.

Drop wires and heddles are extras and should be ordered in sufficient quantity for extra drawing-in sets. Each set of harness has two bars and each set of drop wires one bar to string them on.

How many extra Drop Wire or Heddle Bars are required for drawing in sets?

What size Driving Pulley?

Regular size 12 inch for 28 inch loom, 14 inch for 40 inch loom.

LOOM DIMENSIONS.

NAME.		Length of lay for 14½ inch Shuttle.	Harness Space.	Greatest width of cloth at Temple.	Width between Beam Heads.	Width of loom from full 16½ inch yarn beam to 9 inch, ('94) 10 inch ('95 and '96) cloth roll.	Width of loom from full 16 inch yarn beam to 18 inch cloth roll.
28 in.	'94 Pattern	73 in.	33 in.	30 in.	31½ in.	46 in.	50 in.
"	'95 "	76 "	35 "	32 "	33½ "	45 "	50 "
"	'96 "	76 "	36 "	32 "	33½ "	46½ "	48½ "
30 in.	'94 Pattern	75 in.	35 in.	32 in.	33½ in.	Same figures apply to all widths of loom. Add two inches for 18 inch yarn beam.	Same figures apply to all widths of loom. Add two inches for 18 inch yarn beam
"	'95 "	78 "	37 "	34 "	35½ "		
"	'96 "	78 "	38 "	34 "	35½ "		
32 in.	'94 Pattern	77 in.	37 in.	34 in.	35½ in.		
"	'95 "	80 "	39 "	36 "	37½ "		
"	'96 "	80 "	40 "	36 "	37½ "		
36 in.	'94 Pattern	81 in.	41 in.	38 in.	39½ in.		
"	'95 "	84 "	43 "	40 "	41½ "		
"	'96 "	84 "	44 "	40 "	41½ "		
40 in.	'94 Pattern	85 in.	45 in.	42 in.	43½ in.		
"	'95 "	88 "	47 "	44 "	45½ "		
"	'96 "	88 "	48 "	44 "	45½ "		

How many Right Hand Looms belt from above?

How many Right Hand Looms belt from below?

How many Left Hand Looms belt from above?

How many Left Hand Looms belt from below?

What size Beam Head is required?

(16½ and 18 inch ordinarily furnished. Send sample beam if we are to match those you are now using.)

How many extra Shuttles do you require?

Only one included per loom without extra cost.

How many Filling Bobbins shall we order for you?

This bobbin is patented and must be ordered through us.

What traverse?

Shall they be oil filled? (One dollar per thousand extra.)

Shall we supply the Temples?

What pattern?

Temples are always extra, not included in loom price. If ordered through supply houses be careful and specify thread cutting temples on half the order.

By what lines shall we ship?

We furnish looms with filling changer, warp stop motion, check stands, shuttle guard, filling fork, one shuttle, one and one half beams. No leather parts.

Pickers must be of short pattern not projecting above shuttle box. Extra pick gears ½ cent per tooth.

Other sizes in proportion for same class of work.

When traverse on bobbins or cops is longer than 5 1-2″ we must increase the length of the shuttle and length of the lay. Length of lay increases twice that of extra shuttle length.

We do not recommend our looms for fabrics wider than the name of the loom implies, although the '95 and '96 pattern can weave two inch wider goods with disadvantage of too short shuttle box.

Be careful not to have posts come so as to prevent a warp beam from being put into the looms. Eight inches space should be allowed between a post and a full beam in the loom.

In ordering harness be careful to have the lower bar less in length than the "harness space" above specified.

The "reed space" is six inches wider than the name of the loom on the '94 pattern, and 5½ inches wider on the '95 and '96 patterns.

INSTRUCTIONS FOR RUNNING NORTHROP LOOMS.

As at present developed the Northrop Loom is entirely new in mechanical features, and certain points already discovered may serve to aid those engaged in running them.

The Loom as left by our men is supposed to be ready for strapping and starting. No new mechanism starts as well as it will run after a little use, and nothing more should be expected. There will be more trouble with breakage of warp and filling at the start, as every place that contacts with warp or filling threads needs the polish that only use can give.

SPEED.

We do not believe in high speed for a machine with so many irregular motions as are necessary in weaving. Our looms will run at any usual speed, but we have found that economy of running, all things considered, points to moderation. We think nothing can be gained by running a 28-inch loom over 185 picks. The saving on warp breakage and loom fixing will easily outweigh the slight possible increase in production of a higher speed. We have run a single loom at 260 picks, to prove our motions did not have to be favored.

OIL.

Always be liberal with oil on a new mechanism. The fits are closer than they will be after wear. As the help are not used to the new parts, they are very likely to neglect proper oiling.

SIZING WARP.

When using the drop wire cotton harness stop motion, it is necessary to size the warps harder than with the usual loom, or put the size *into* the yarn instead of having it on the outside of the yarn as is the case in a great many mills. The test of proper sizing is the amount of lint, and the warp breakage. On No. 28 yarn, warp should not break more than 15 to 20 threads per day. With poor sizing this can easily run up to 50. The slasher speed has considerable to do with proper sizing. A slow speed, of course, results in a larger per cent. of size in the yarn. With the steel harness motion, no extra sizing is required.

BROKEN SHUTTLES.

On the filling motion, if the mechanism is properly set, no trouble should ensue. Sometimes, however, a broken bobbin or shuttle will prove something needs attention. The probability is that the shuttle position detector is not working properly. This device should prevent the transfer of a bobbin in case the shuttle does not reach home, or rebounds excessively. Try this device by turning the loom over by hand with the shuttle out of place.

Sometimes through carelessness the shuttle is put in the loom wrong end foremost. This has actually caused considerable trouble in our experience.

It is also possible that the lay may have settled down so that the transferrer does not press the bobbin far enough down into the shuttle. This can easily be remedied by adjusting the screw on the notched dog hanging from the transferrer. Whenever the speed of the loom is changed appreciably it will probably be necessary to change this adjustment.

Should neither of these troubles be found, it may happen that there is too much or too little leather in the end of the shuttle box. While there is supposed to be enough leeway to accommodate the usual variation, a new picker or badly worn one, may stretch the limit.

Sometimes the trouble is unaccountable, and it is then well to note the loom and see if it is repeated. It may be purely accidental. and not likely to happen again. Of course any evidence of broken or misplaced parts is easily noted and corrected. It is often well to turn the loom over by hand and watch it change bobbins slowly. Our present shuttle will resist breakage much better than those we first sent out. Barring accidents, our shuttles will outwear any in the market.

Save broken shuttles and return to us. We use the metal parts, when possible, in repairs, and sell shuttles so repaired at half price. They are practically as good as new for use.

MISTHREADING.

When the shuttle fails to thread, or "Misthreads," as we term it, the fact is not alarming unless excessively repeated. The weavers will at times neglect to place the threads in the proper notches on the hopper, and there are of course weak places in the filling. If excessive, however, there is probably trouble in the filling, the shuttle, or in the loom. When the pick is too hard the rebound tends to throw the filling out of the slot. The shuttle eye is liable to become clogged at times, and the weaver should learn to look out for this. The shuttle may have struck the top of the shuttle box and jammed the brass so as to close the threading slot. Another possibility is that the fork may not lift, or may rebound. Test looms for misthreading by holding down the filling fork with the finger. Do not try experiments by changing the setting of the disc or filing the shuttles. These points have been settled by years of experiments.

BOBBINS NOT WEAVING OFF.

When the bobbins fail to weave off properly and the filling is properly spun, look for defects in the shuttle. There may be cracks or sharp corners due to splits or wear. Also look for defects in the shuttle boxes or pickers, as the thread is bound to fly out and catch if there is a place for it to catch in. The fork may possibly be set too sensitive. With long traverse bobbins, or coarse yarn, it may be necessary to use some sort of friction in the shuttle to prevent filling flying out and catching. Bunches of bristles set in holes in the shuttle side are often very effective. Trouble with filling is often due to poor spinning. The traverse on the bobbin may be wrong, or the bobbins not wound hard enough, or filled too full. Do not allow weavers to cut yarn from the bobbins. Every yard can be woven off and should be.

STOP MOTION.

As to the action of the stop motion, the only troubles will be the failure to stop promptly, and possibly small overshots. When a detector fails to stop promptly, and no fault is found with the set of the vibrator, it is possible that lint may clog the proper action. Lint will not cause trouble with warps properly sized. Sometimes a thread will snarl in such a peculiar manner that it will hold the detector up for some time after it is broken. As to overshots, they are usually due to poor setting of the stopping mechanism. Single threads sometimes come so slack as to cause trouble, but the set of the vibrating detector at proper distance from the detectors will cure most of this. For the first week or two there will be much more warp breakage than later on. No mechanical process can polish these metallic pieces equal to the friction of the cotton threads. The vibrator should have its spring act easily, as if the spring is set too strong the drop wires are liable to be bent at the ends.

SELVAGES.

With all warp stop motions, we recommend the use of twisted selvage threads, although many mills having our looms run without them. Where double selvage threads are used, the warp stop motion cannot act unless both threads break out together.

SETTING THE PICK.

Set the pick as easy as possible and have the shuttle throw straight. These shuttles are necessarily expensive, and more than usual care should be taken to prevent wear. Use good leather for check straps. We will send sample pattern if desired. When a loom is found stopped with an empty bobbin in the shuttle, it is a sure sign that the pick needs setting, as it shows that the shuttle position device has prevented the transfer of a bobbin. This shows a lack of power or a too tight shuttle box.

BOBBINS.

The overseer should insist on having bobbins properly wound in the spinning room. The traverse should not be too slow and the wind should be as hard as possible. If, when frames are doffed they stop with the rail at the bottom of the wind, it will help in the weaving as the thread will start to unwind better from the large circle. As the weave room is usually damp, bobbins are apt to warp and need reaming. Do not attempt to use a bobbin that has had any accident to the rings. Care should be taken in mills running old looms to see that bobbins are not mixed. If a common bobbin gets into a loom hopper by mistake, it is almost certain to make a break out.

SHUTTLES.

Do not try to run shuttles after they are damaged, unless the damage is capable of being cured. The accidents liable to happen in use are splitting, spring loosening, and brass jamming or wearing. If the wood is badly split it is usually bad policy to try repairs. The spring ought not to loosen, but if it does it may be wedged tight. Any damage to the brass eye ought to be capable of cure with a small file or fine emery cloth.

BOLTS AND SCREWS.

Any new loom will loosen screw parts in the first few days it is run. By carefully tightening all bolts and screws after the first running, there should no further trouble.

TRAINING HELP.

In training weavers, teach them to economize their time as much as possible. Have them fill hoppers when all their looms are running. Make them place filling threads in the proper hopper notches.

Fixers should not be allowed to try experiments with the devices. Teach them one way to set the devices, and keep them to that method.

A new machine always frightens an unskilled hand. There is nothing about this loom however that ordinary common-sense cannot handle. The fact that these looms are running successfully in mills at the present time, should assure overseers and fixers that they can be mastered.

MORE DEPENDS UPON THE PROPER USE OF OIL THAN ANY OTHER PRECAUTION.

Ninety-nine per cent. of the troubles we have found in starting looms come from neglect in following such advice as we were glad to offer. We cannot accept responsibility for difficulties that are not guarded against by following our precautions. In the use of a new loom like this the real or fancied troubles are usually all laid to the new devices when they may merely result from poor loom fixing. We do not claim to have conquered all the difficulties of old looms, and our let-off, take-up, pick motion, etc., are of the usual old pattern (except in detail), and liable to the usual old troubles.

It may as well be understood now as at any time that these looms have passed the experimental stage and are going to be introduced. We make this statement advisedly, and those knowing our record in connection with other cotton machinery improvements will make arrangements accordingly.

LOOM TEMPLES.

The object of a pair of temples is to keep the cloth at the proper width during the process of weaving, and also to prevent the warp being drawn in or condensed near the selvages by the drag of the filling. The strain on the warp is so great that it is impossible to keep the cloth at the temple as wide as the space occupied by the warp in the reed. A good temple, however, will keep the cloth as near this width as is necessary. Modern requirements also demand self-action, adjustment and freedom from accident and repairs.

The earliest invention in this line consisted of two flat pieces of wood with points set in one end of each. These were tied by a cord after being adjusted to the width of the goods, and were moved forward from time to time by the weaver. The next improvement was the jaw temple, on the same principle, made self-acting, however, by the motion of the lay. The first practical rotary temple was invented and introduced in this country by Ira Draper, an ancestor of the present firm members. This temple, as further improved by George Draper, went into extensive use, and even at the present time we are called on to fill small orders of this type.

The next vital improvement was the reciprocating temple, invented by Mr. Warren W. Dutcher, for whom the Dutcher Temple Company is named. His inventions in temples and machinery for making them have developed so as to control the entire temple business of this country.

The original forms have been so greatly improved as to strengthen our hold on the trade, and it is doubtful if any temple not up to our present standard and infringing our present patents, would be used by manufacturers even if given away. Our present temples have improvements never before referred to in our books or circulars, and they are fully as important as any we have formerly called attention to. They relate to improvements in the rolls and the manner of setting the teeth, the results accomplished being perfect selvages on any goods without temple marks. This could never be guaranteed with any former style of temple. Mills are already familiar with our other recent improvements, such as the oilless wooden roll bearing which cannot mark the cloth; the positive lock for the pod, preventing the roll teeth from ever striking the bar; the covered spring, and the new metal adjustment plates. All these improvements make our temples more expensive to manufacture, and also make them more valuable to the manufacturer. We have not increased our prices, however, and trust the public will appreciate this fact.

We call attention to our new breast beam plate, which, when once attached to the loom, need never be moved, as the temple is adjusted on the plate and can accommodate all probable changes of width in goods woven. For woolen goods we have the Hardaker and Knowles patterns, both of which are extensively used. All our temples are made interchangeable and the workmanship and finish is of the usual Dutcher Temple Co. standard. This company manufactures all these styles of temples, and also nearly a hundred other patterns which have been introduced at different periods, and are still used by mills that have grown accustomed to old styles and send duplicate orders. As we know our present patterns are much more efficient, we discourage such a course whenever possible. We only illustrate our present improved types.

George Draper & Sons are the sole agents for the sale of these temples, but they in turn allow sales by certain commission houses at fixed prices. No expense is spared to make them as perfect as possible, and to make all styles of one standard.

TEMPLE ROLLS.

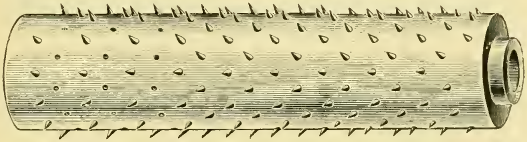
The roll is the vital feature of a temple, and is the main point to be considered in deciding what temple shall be used. We have evolved many different styles to accommodate the great variety in cloth woven. We are now confident that we can properly temple any goods without marking or otherwise damaging the selvages. If trouble is encountered in any mill, we will be glad to send our expert to advise on the difficulty. Our rolls are divided into several classes. We have two regular lengths, and can make a third by doubling our short length. Our rolls usually have the same diameter for the outside tooth circle, but the wood is turned in various diameters in order to allow the points of the teeth to project varying distances. A new feature used for certain goods is our taper set, by which the teeth project farther at the selvage. Another new feature is used sometimes on the selvage end of the roll, and consists in having half the usual number of teeth. These modifications are patented, and have proved very important in preventing temple marks on certain goods. Our rolls are also divided in two classes, as follows, which divisions, however, have nothing to do with the effect on the cloth. Our latest improved style has a wood bushing inserted at each end to run on hardened steel pins. These bushings are prepared with an anti-friction compound and will not require oil. This point is very important, as it absolutely prevents oil marks on the cloth from this source. These rolls cannot be put in wrong end foremost, which fact prevents a former common mistake. Our old style roll has a center hole running its entire length to serve as a bearing for a long roll pin, and we do not recommend these to be run without oiling.

Our regular line of rolls is shown in the following list. It does not pretend to show every modification, however, as it is to be understood that these rolls are made with varying diameters, and each style of roll can be adapted for either style of bearing. We show the most used forms in the cuts. We usually select the rolls ourselves when filling temple orders, being guided by the cloth specified. Our customers may wish to choose for themselves, however, in which case, of course, our responsibility ends.

Short rolls are 1 3-4 inches long. Long rolls are 2 1-2 inches long.

LONG ROLLS.

No. 1.

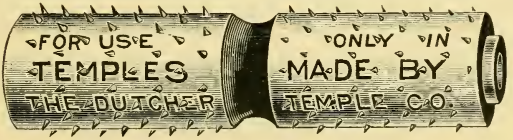


Name—Eureka No. 1, small dia. roll, taper set, half number of teeth on selvage, wood bushings.
(Small roll signifies small diameter of wood.)

Use—This is a standard pattern for all medium grades of goods, 36 to 40 and above. Used regularly in our No. 76 temple.

Variations—Also made with center hole for long bearing.
Also made large diameter.
Also made with full number of teeth on selvage.

No. 2.

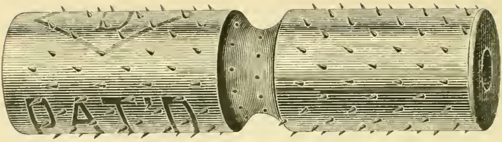


Name—Eureka No. 1, grooved, small dia. roll, taper set, wood bushings.

Use—For ordinary sheetings or shirtings.

Variations—Also made with center hole for long bearing.
Also made large diameter.
Also made with half number of teeth on selvage.

No. 3.

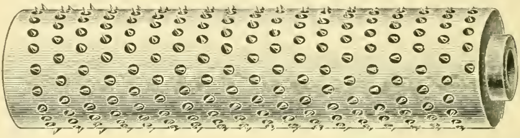


NAME—Eureka No. 1, grooved, large dia. roll, long bearing.

USE—For fine sheetings and shirtings.

VARIATIONS—Also made with wood bushings.
Also made small diameter.

No. 4.



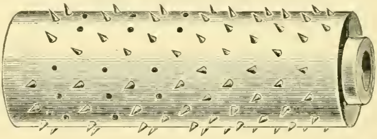
NAME—Special Eureka No. 1, roll, counter sunk teeth, taper set, wood bushings.

USE—For very fine goods.

VARIATIONS—Also made with long bearing.

COMMON SHORT ROLLS.

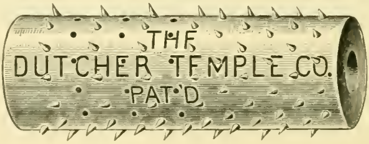
No. 5.



NAME—Common, small dia. roll, taper set, half number teeth on selvage, wood bushings.

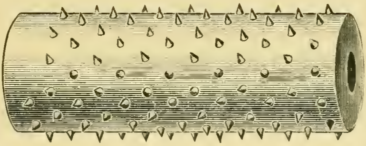
USE—For narrow goods.

VARIATIONS—Also made for long bearing, as below.

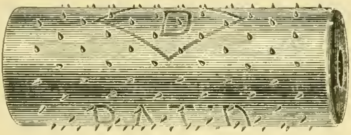


Also made large diameter.
Also made with full number of teeth on selvage.

No. 6.

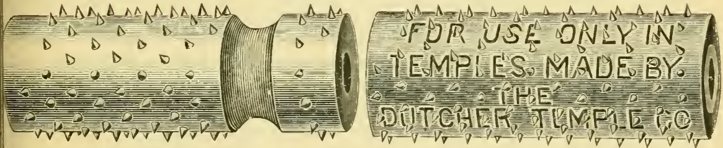


NAME—Common, small dia. roll, long bearing.
USE—For Prints, etc.
VARIATIONS—Also made with wood bushings.
Also made large diameter, as below.



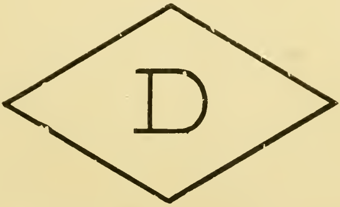
DOUBLE ROLL.

No. 7.

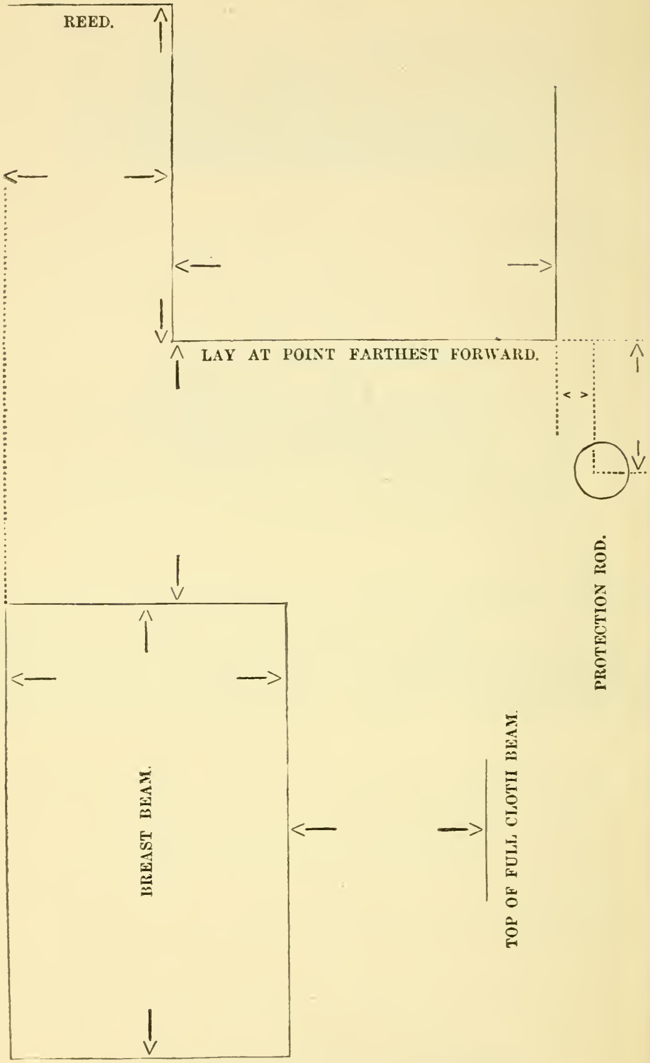


NAME—Eureka No. 2 double roll.
USE—For very heavy or very wide goods with No. 84 or No. 85 temple.

All temple rolls manufactured by the Dutcher Temple Co. are marked with their trade-mark, which has been duly registered at the Patent Office, together with the statement:



"FOR USE ONLY IN TEMPLES MADE BY THE DUTCHER TEMPLE CO."



SPECIFICATION FOR PATENT LOOM TEMPLES.

Give measurement in inches between all points indicated.

Number of Looms. Maker of loom. Kind of temple.

Breast beam of iron or wood. Kind of goods woven.

Give diameter and position of any rods between breast beam and lay, or within two inches of underside of lay or breast beam.

Blank specification will be sent on application.

Apart from the roll, the rest of the temple varies in form to suit the customer. Some mills prefer spring temples, and others hinge temples. The regular reciprocating styles Number 76 or 78, are at present most popular on account of recent improvements. Our hinge temples are more satisfactory than ever, and provide for easy replacement of hinge bearings in case of wear.

Many mills persistently order old styles of temples, which we do not now recommend. We can, of course, supply them, but there is no reason why the mill should handicap itself in this way. Wear, repairs and *effects* are all strongly in favor of the recent patterns.

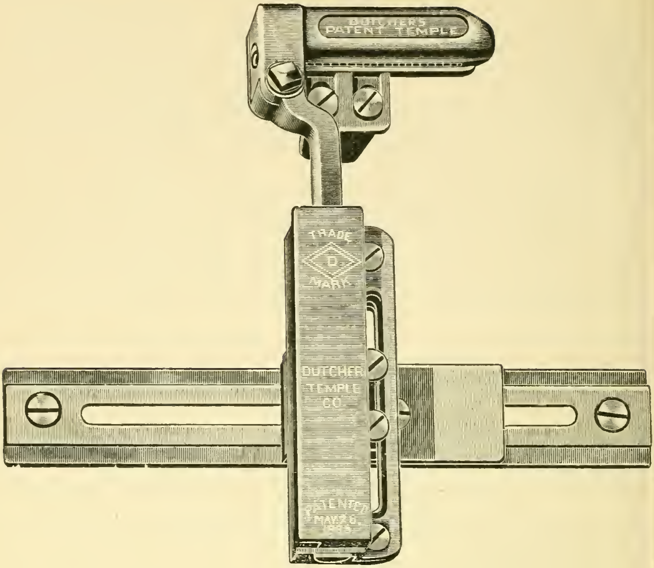
In ordering note carefully the specification on the opposite page.

NAMES OF PRESENT STANDARD PATTERNS SHOWN IN FOLLOWING PAGES.

No. 76 Dutcher Temple.
No. 78 Dutcher Temple.
Dutcher Hinge Temple, 1894 pattern.
No. 87 Dutcher Spring Temple.
No. 88 Dutcher Spring Temple.
No. 89 Dutcher Spring Temple.
No. 84 Dutcher Temple.
No. 85 Dutcher Temple.
Hardaker Patent Temple.
Knowles Patent Temple.

The first six are fitted with either wood bushed rolls or center bearing as desired. Nos. 84 and 85 always have long centre bearing.

In ordering temples of old patterns or repair parts for same, specify names by old temple circulars or cards, or if in doubt, send samples.



DUTCHER PATENT NO. 76 TEMPLE.
(Shown with Honan Plate. Can be had without but the Honan is best.)

TECHNICAL NAMES OF PARTS.

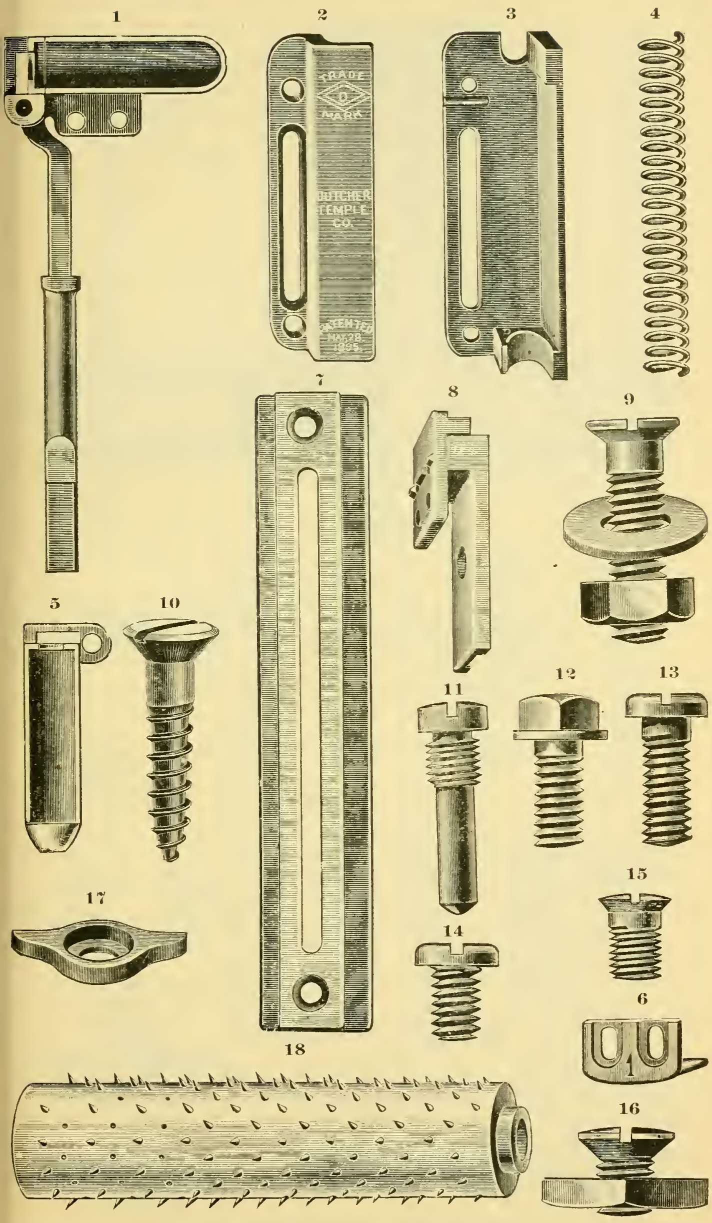
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Plate Screw and Nut.
17. Roll Guard.
18. Roll.

Parts 5, 6. 7, 8 and 18 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "Left Top for No. 76 Temple."

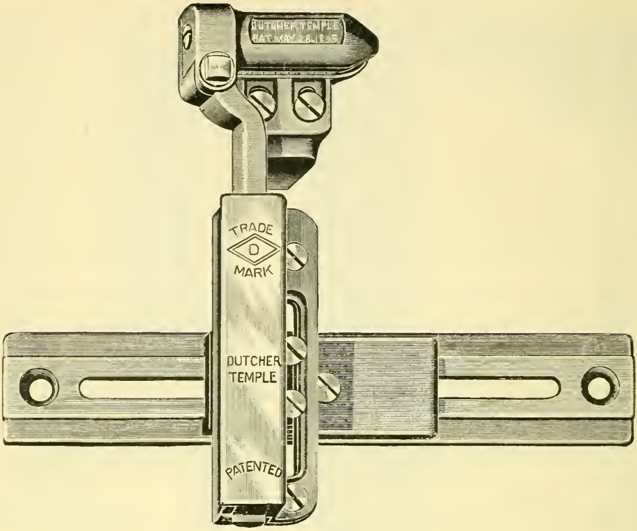
Parts 1, 2, 3, 5 and 8 are made rights and lefts.

Parts 1 to 8 are shown one-third size.

Parts 9 to 18 are shown full size.



PARTS OF NO. 76 TEMPLE.



DUTCHER PATENT NO. 78 TEMPLE.

(Shown with Honan Plate. Can be had without but the Honan is best.)

TECHNICAL NAMES OF PARTS.

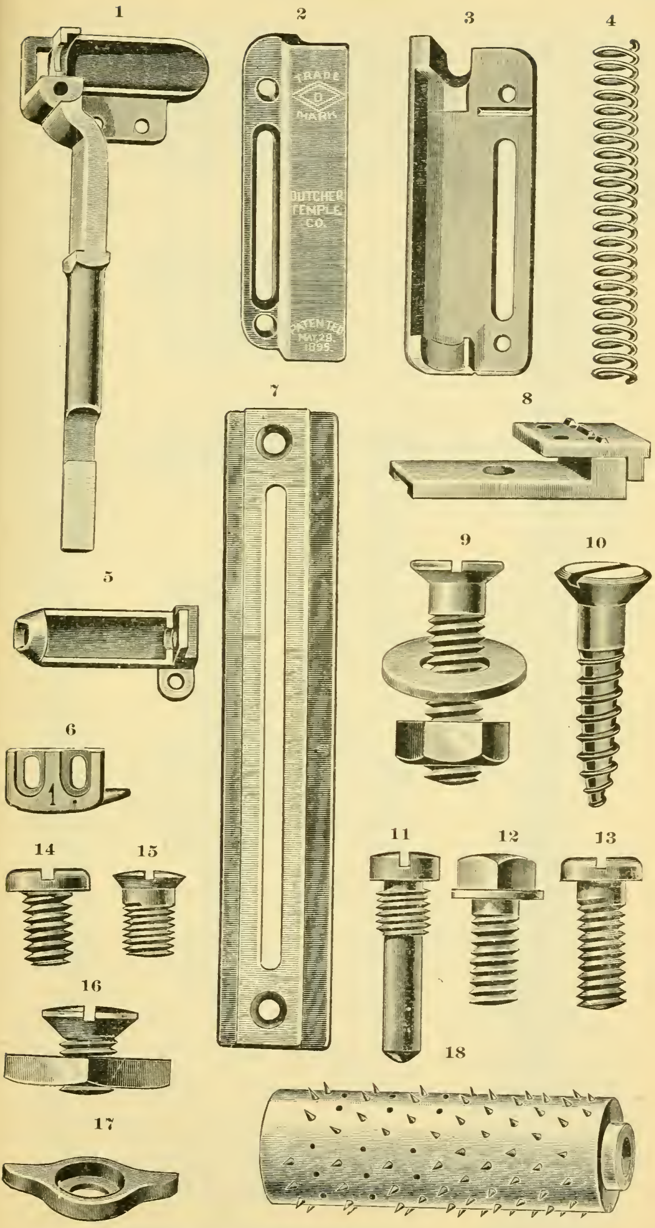
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Plate Screw and Nut.
17. Roll Guard.
18. Roll.

Parts 5, 6, 7, 8 and 18 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "Left Top for No. 78 Temple."

Parts 1, 2, 3, 5 and 8 are made rights and lefts.

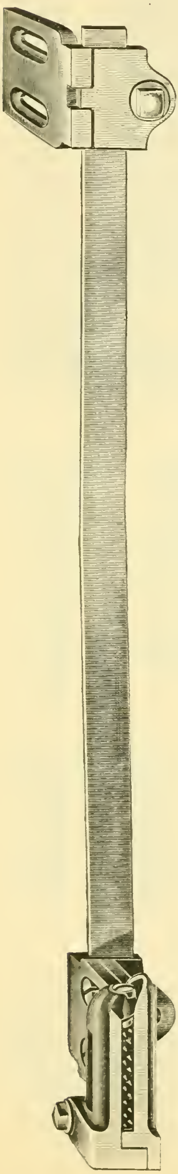
Parts 1 to 8 are shown one-third size.

Parts 9 to 18 are shown full size.



PARTS OF DUTCHER NO. 78 TEMPLE.

DUTCHER PATENT SPRING TEMPLE
No. 87.



Also made in styles Nos. 88 and 89, distinguished by different lengths of heel.

Patented May 28, 1895.

Spring 17 inches long with 1 inch offset unless otherwise specified.

Face plates to carry spring forward from 3-4 to 1 3-4 inches.

TECHNICAL NAMES OF PARTS.

1. Spring.
2. Face Plate.
3. Top Plate.
4. Pod.
5. Top.
6. Heel and Plate Clamp.
7. Heel.
8. Face Plate Screw and Washer.
9. Top Plate Screw.
10. Roll Pin.
11. Plate Clamp Screw and Washer.
12. Top Screw.
13. Heel Screw.
14. Plate Bolt Nut and Washer for Iron Breast Beam.
15. Roll.
16. Roll Guard.

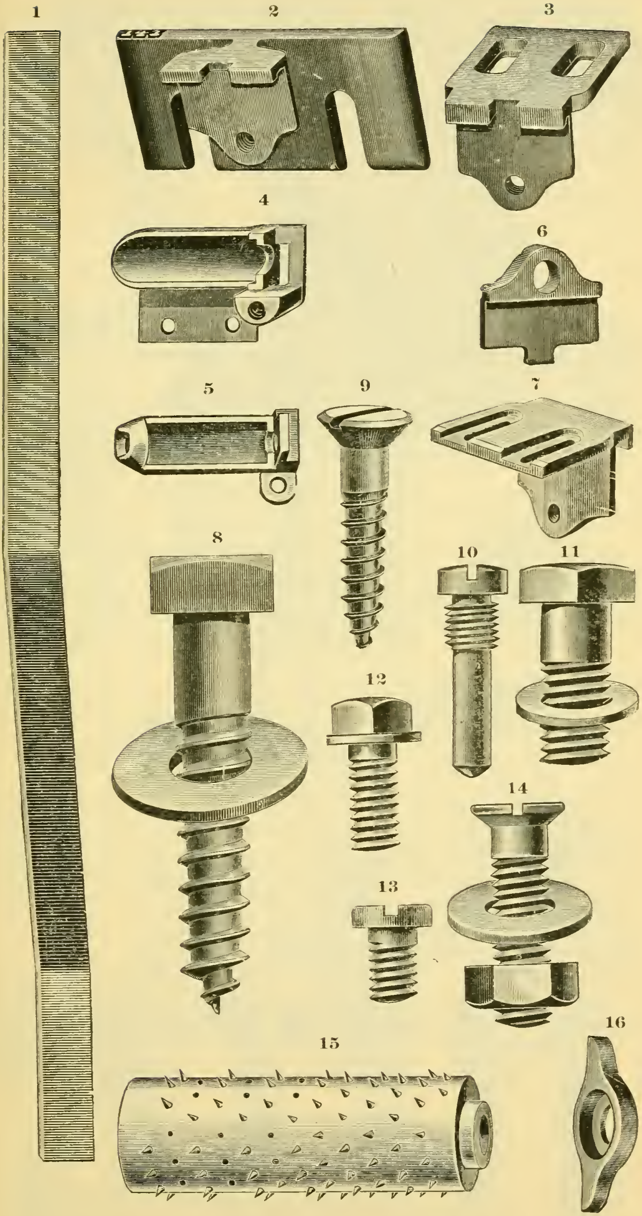
Parts 1, 4, 5, 7 and 15 are made in different shapes and sizes, and must be ordered by sample or by number on pattern, The rest can be ordered by this list, as, "Face Plate for '87 Spring Temple."

Parts 4 and 5 made in rights and lefts.

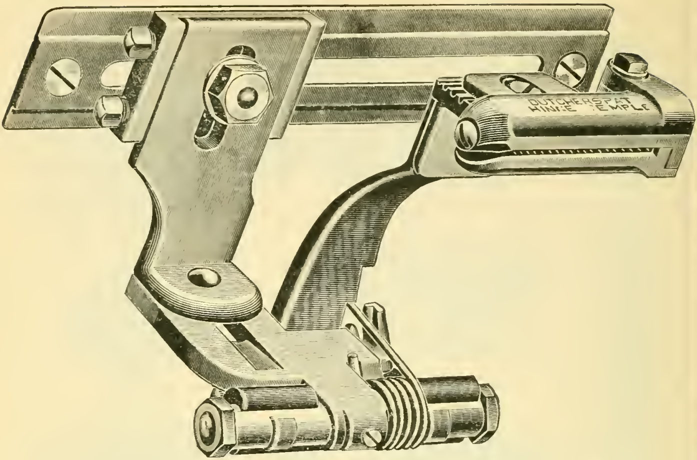
Parts 1—7 shown 1-3 size.

Parts 8—16 shown full size.

Also made with long roll.



Parts of Dutcher Patent Spring Temple No. 87.



DUTCHER PATENT HINGE TEMPLE, 1894 PATTERN.

TECHNICAL NAMES.

1. Swing.
2. Base Plate.
3. Extension.
4. Stand.
5. Extension Pin.
6. Slide.
7. Pod.
8. Top.
9. Spring.
10. Heel.
11. Roll.
12. Roll Guard.
13. Nut for Extension Pin.
14. Bearing.
15. Stand Bolt, Nut and Washer.
16. Stand Screw and Washer.
17. Bolt, Nut and Washer for Iron Breast Beam
18. Screw for Wood Breast Beam.
19. Roll Pin.
20. Top Screw.
21. Slide Screw.
22. Pod Bolt and Nut.
23. Extension Pin Screw.
24. Heel Screw.

Parts 1, 2, 3, 4, 7, 8, 9 10 and 11 are made in different shapes and sizes. They must be ordered by sample or by number on pattern.

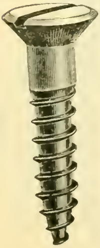
The rest can be ordered by this list, as, "Bearing for 1894 Hinge Temple."

Specify Rights and Lefts when necessary.

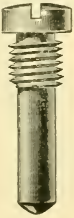
Parts 1 to 10 and 14 are shown one-third size.

Parts 11 to 24, except 14, are shown full size.

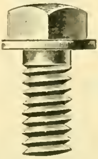
18



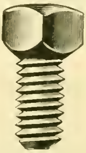
19



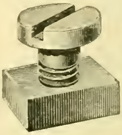
20



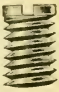
21



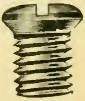
22

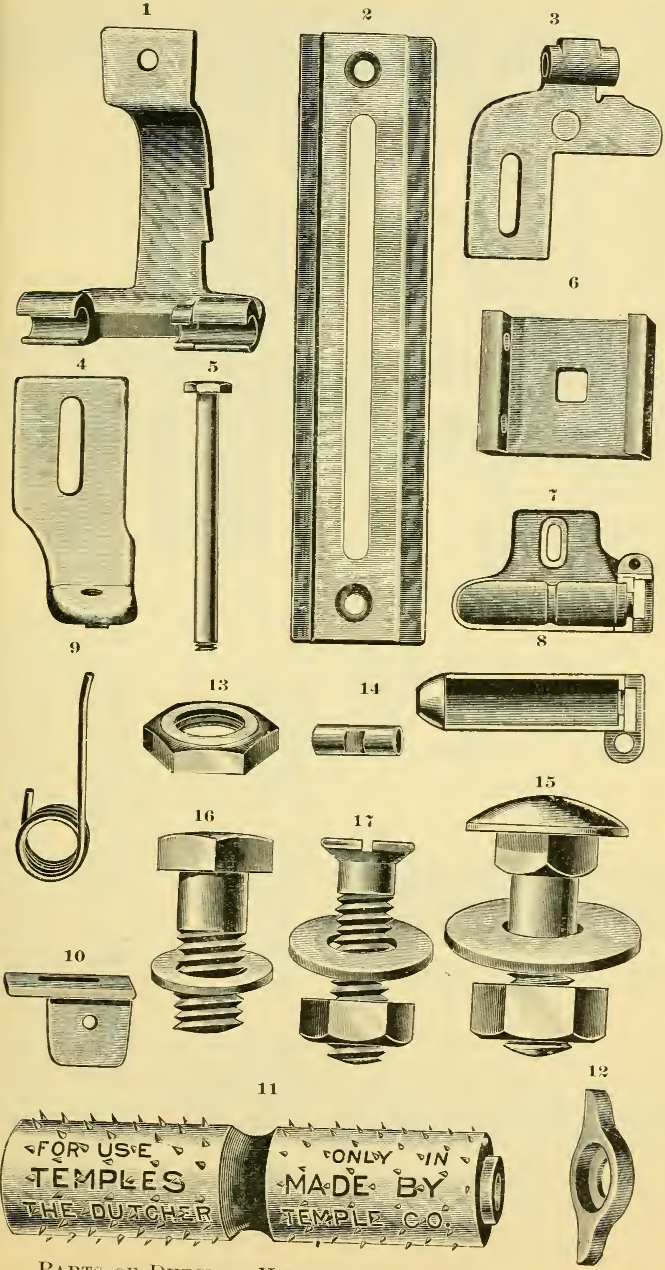


23

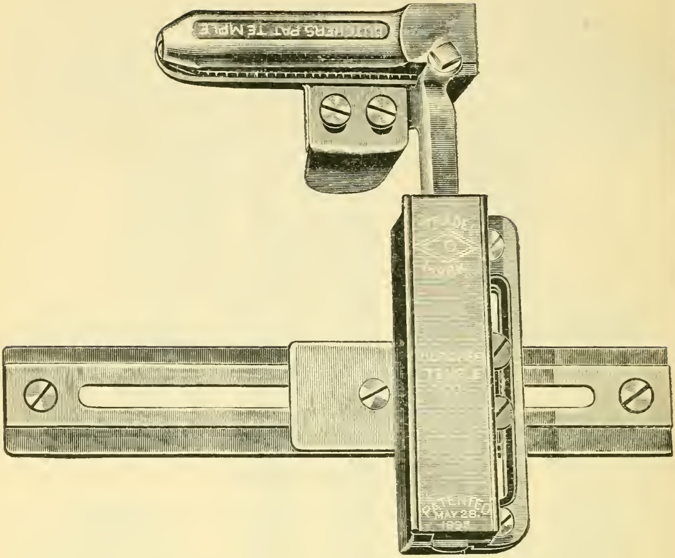


24





PARTS OF DUTCHER HINGE TEMPLE, 1894 PATTERN.



Dutcher No. 84 or 85 Temple.
(Shown on Honan Plate.)

No. 84 has bar 9 1-2 inches long.
No. 85 has bar 10 inches long.

TECHNICAL NAMES OF PARTS.

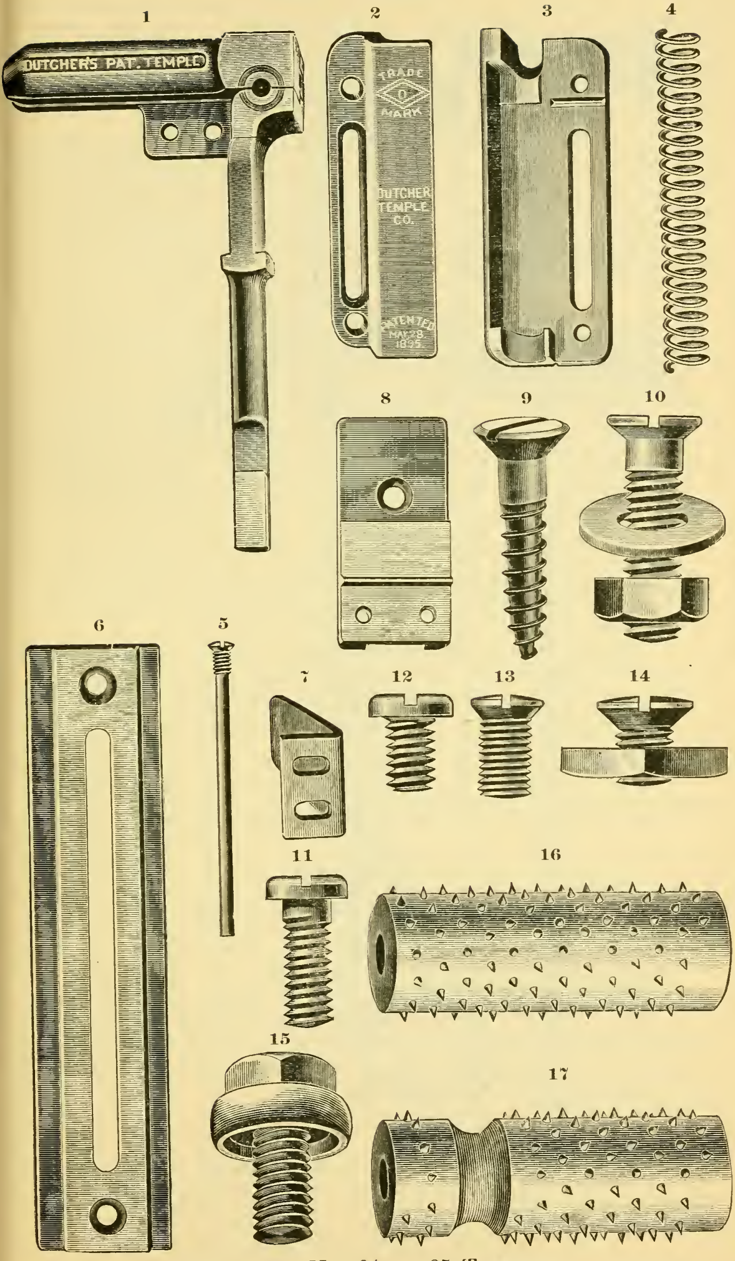
1. Bar and Top.
2. Cap.
3. Stand.
4. Spring.
5. Roll Pin.
6. Base Plate.
7. Heel.
8. Slide.
9. Plate Screw for Wood Beam.
10. Plate Bolt, Nut and Washer for Iron Beam.
11. Stand Screw.
12. Heel Screw.
13. Cap Screw.
14. Plate Screw and Nut.
15. Top Screw.
16. Outer Roll.
17. Selvage Roll.

Parts 1, 6, 7, 8, 16 and 17 are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as, "Stand for left hand No. 84 Temple."

Parts 1, 2, 3 and 8 are made rights and lefts.

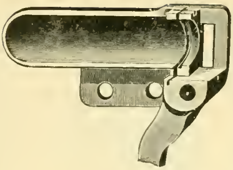
Parts No. 1 to 8 shown one-third size.

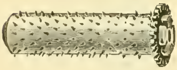
Parts 9 to 17 shown full size.

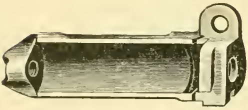


Parts of No. 84 or 85 Temple.

STIMPSON THREAD CUTTING TEMPLE.







This is for use on Northrop Looms, where it severs the thread extending from the edge of the cloth to the Hopper disk, when a fresh bobbin or cop is transferred to the shuttle, and its first shot of filling woven. Unless this thread is cut, the selvage will have long ends and some of them may get woven in at the edge. As will be seen in the cut the invention consists in applying a toothed circular disk to the temple roll, and in providing grooves and notches so as to admit the thread to the cutter and allow it to engage the same. Only one temple of this kind is necessary per loom.

The original thread cutting temple patent is in the name of Wm. F. Draper, E. S. Stimpson and James H. Northrop. This present modification is in the name of E. S. and W. I. Stimpson.

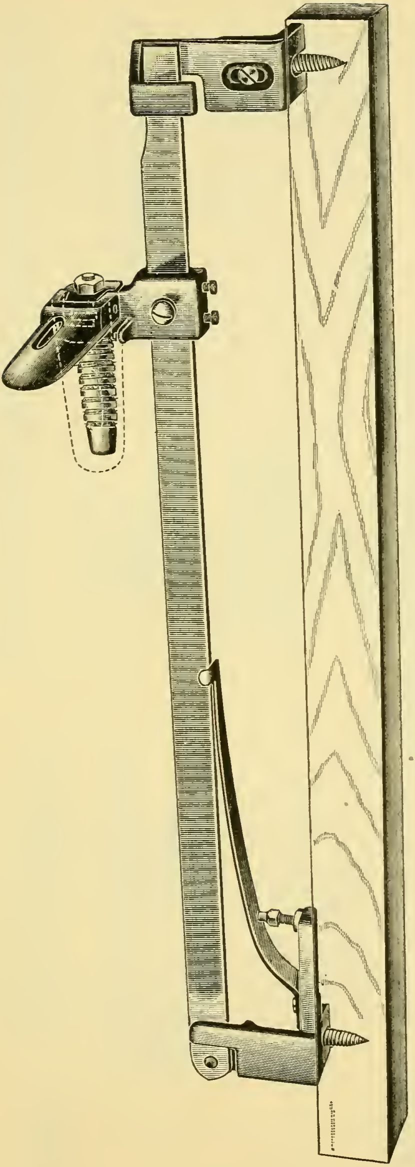
When temples for Northrop Looms are ordered through us with the loom order we will see that thread cutting temples are sent. When orders come in from outside shops, or supply houses, it will be necessary to specify on order that thread cutting temples are wanted.

This idea does not apply to the common loom. It will *not* sever the usual selvage fringe ends on such looms.

THE KNOWLES TEMPLE.

The Knowles temple is a modification of the Hardaker, especially arranged for application to the Knowles looms, and is the form recommended by them for their woolen and worsted looms. It has less motion than the Hardaker being only intended for open shed weaves.

This temple is placed first simply for convenience in pageing. The Hardaker is the regular model for these goods.



THE KNOWLES TEMPLE.

DUTCHER PATENT "KNOWLES" TEMPLE.

TECHINICAL NAMES OF PARTS.

1. Bar.
2. Spring.
3. Swivel.
4. Inner Bracket.
5. Stop.
6. Outer Bracket.
7. Head.
8. Bracket Screw and Washer.
9. Tension Screw.
10. Head Screw.
11. Swivel Screw.
12. Top.
13. Top Pin.
14. Roll.
15. Roll Nut.
16. Spring Screw.
17. Lock Screw.

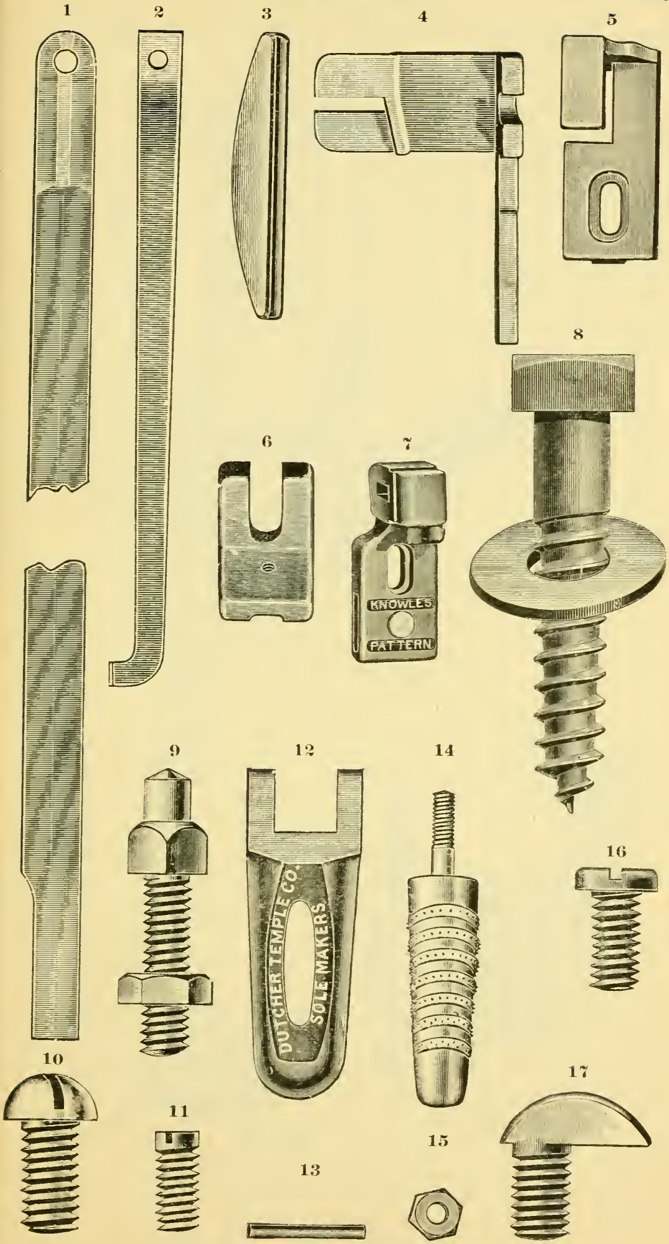
Parts 2, 4, 5, 6, 7 and 12 are made in Rights and Lefts.

Parts 2, 4, 5, 6, 7, 12 and 14 are made in different shapes and sizes, and must be ordered by sample or by number on pattern.

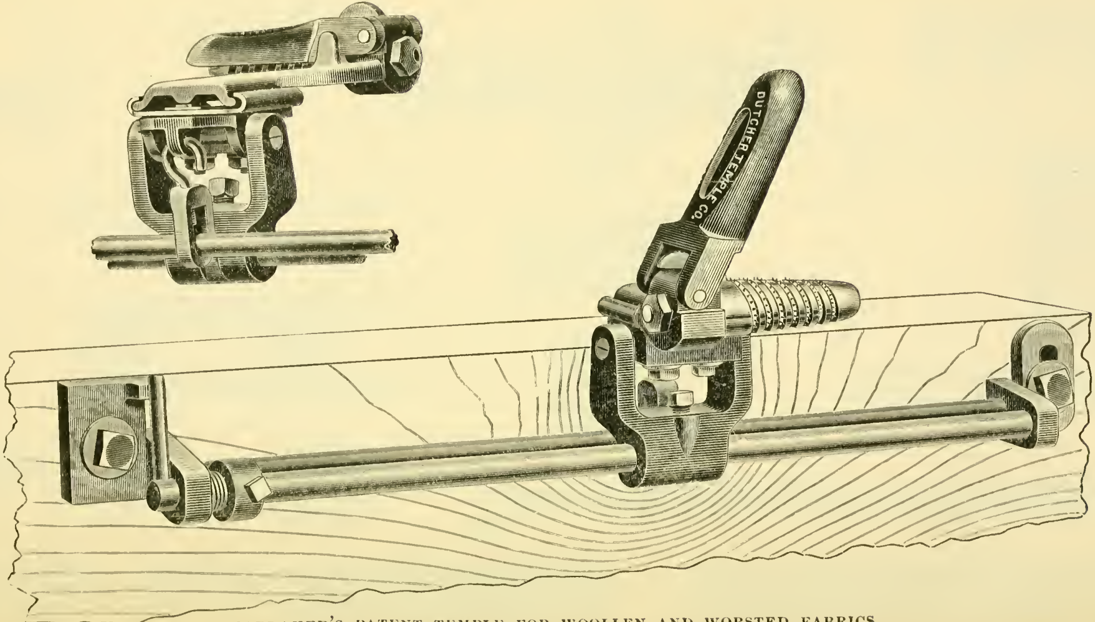
The rest can be ordered by this list, as "Bar for Knowles Temple."

All cuts one-third size, but 8, 9, 10, 11, 16, 17.

Made with 5, 7 or 9 rings to roll as ordered.



Parts of Knowles Temple.



HARDAKER'S PATENT TEMPLE FOR WOOLLEN AND WORSTED FABRICS.

HARDAKER'S PATENT TEMPLE FOR WOOLEN AND WORSTED FABRICS.

In weaving the heavier kinds of woolen and worsted goods, there is in almost all looms a considerable horizontal and vertical movement of the cloth; and the temple that offers no resistance to these movements other than the trifling one of its own weight has the greatest merit. It must also be self-acting.

Until the invention of Mr. Hardaker, there was great difficulty in templing heavy and broad cloths in a self-acting manner. It is of the utmost importance to have the temple roll as close to the front of the shed as possible. Sometimes the beat of the reed will move the cloth horizontally an inch or more; and if the temple is rigidly mounted, a distance exceeding this movement must be allowed between the front of the shed and the roll. When the reed recedes, the front of the shed follows it for some distance, and the cloth must also pass or rub back over the roll, and this rubbing may cause marks or other damage near the selvages. Again, to allow for a considerable vertical movement of the cloth a temple with rigid mounting must be set well back from the shed, to enable the cloth to rise and fall without damage to itself. But this necessary setting the roll back from the front of the shed is just what is not wanted, for the simple reason that it does not properly support the selvages to resist the drag of the filling or weft.

To secure proper templing it is necessary to have a mounting which will allow a roll to be placed close to the shed and move in every direction with its changes of position In other words, the temple must rise and fall with the cloth and follow the reciprocating motion of the beat of the reed.

The original Swiss or Mathis temple, known in this country as the Kayser temple, had all the oblique pin rings and washers forming the roll. of the same diameter. This construction caused most of the work to be done by the pin ring nearest the end of the roll towards the centre, or farthest from the selvage, because this first takes the strain, and the pins were liable to leave prominent and objectionable markings on many classes of goods. To avoid this many devices have been tried, of which the most simple and successful is tapering the roll by making the pin rings and washers of successive smaller diameters. It is obvious that the ring nearest the end, or the smallest ring, will draw least and the largest one most; this equalizes the draught of all the rings, and entirely prevents marking or tearing the cloth, and leaves an almost perfect selvage. Our new pattern for light dress goods is made of smaller size and is giving satisfaction where it is in use.

The ingenious arrangement for sliding the head of the temple back, in case it strikes the shuttle or for any other reason, effectually prevents any damage, and is most convenient for removing the roll for examination or other purpose. The slots in the washers between the pin rings forming the roll keep the rings free from dirt or grease; therefore they never stick and seldom need renewing.

The Hardaker Patent Temple is a great advance over any temple previously made for woolen and worsted fabrics. It is readily adjustable, self-acting, not liable to damage or excessive wear, and rises and falls with the cloth and follows the reciprocating motion of the beat of the reed.

DIRECTIONS FOR APPLYING.

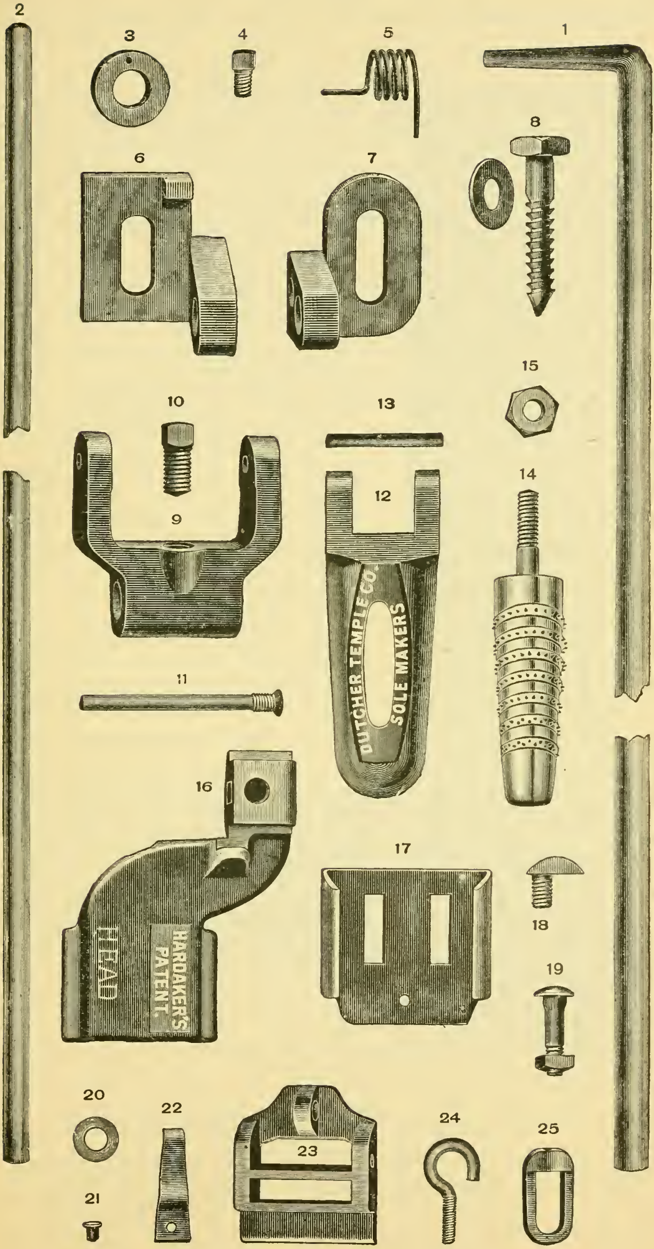
Set brackets flush with top of breast beam. End of rod with spring and collar must be at outside, and bracket set out to full width of reed. The stirrup should be set perpendicular, or leaning a little forward. The head should be set nearly level, or it may lean toward the lay to suit the kind of goods woven; it should also be set as near the reed as is safe and just above the race-board, so that it will clear the corner of the lay. The roll is adjustable in the head for giving more or less bind in the cap. The spring collar should be carefully adjusted on rod to give the temple the same length of movement that the cloth has over the breast beam. The upright pin in the spring end of the rod indicates the motion of the temple and also serves as a stop.

When weaving heavy goods with soft filling the temples should be set in three eighths of an inch at each side to avoid excessive strain. For worsted or cotton-warp goods they may be set out to the full width of the warp.

Technical Names of Parts.

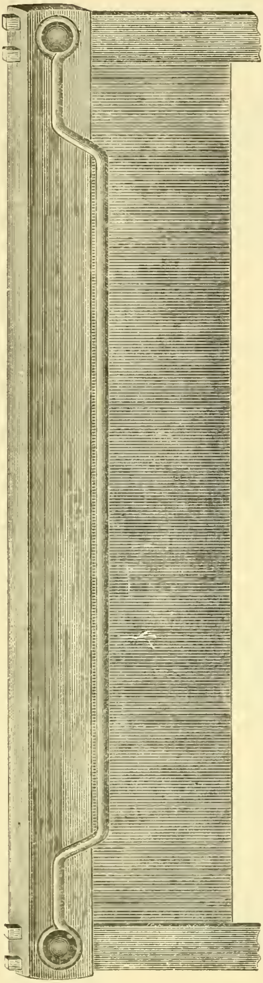
1. Large rod.
2. Small rod.
3. Collar.
4. Collar set-screw.
*5. Spring for large rod.
*6. Outside bracket.
*7. Inside bracket.
8. Bracket screw and washer.
*9. Stirrup.
10. Stirrup set-screw.
11. Saddle pin.
*12. Top.
13. Top pin.
14. Roll.
15. Roll nut.
*16. Head.
17. Head holder.
18. Lock-screw for top.
19. Saddle bolt.
20. Washer.
21. Rivet.
22. Friction spring.
23. Saddle.
24. Hook.
25. Link.

* Parts marked with a * are made right and left.



PARTS OF HARDAKER'S PATENT TEMPLE.

SULLIVAN'S PATENT SHUTTLE GUARD.



These Shuttle Guards are made of the best quality coppered wire, five sixteenths of an inch in diameter, and are long enough to reach the entire length of the hand-rail. An eye is formed in each end, and these eyes fit over the bolts which attach the hand-rail to the swords. No other fastening is required, except for certain widths of looms, when a center support is added. The guard fits closely to the hand-rail for about three inches at each end and is then bent to hang over the race in any position desired.

This form of construction and attachment makes the most simple and durable shuttle guard that has thus far been introduced.

The hand-rail is not cut or damaged in any way in making the attachment, nor are there any bolts, screws, or other fastening, such as have to be used with other guards, to work loose and annoy and hinder the weavers. In weaving extreme width goods on narrow looms this guard has an advantage over others in having no bolt ends to project from back of hand-rail to tear or damage the harness.

This guard can be applied for repairs where it would otherwise be necessary to renew the hand-rail, at less than half the cost of making and fitting a new hand-rail. There are thousands of them in use.

DIRECTIONS FOR ORDERING.

Give length between centers of bolts that attach hand-rail to swords, and distance it is desired to have the guard project forward from face of hand-rail and down below centers of bolts.

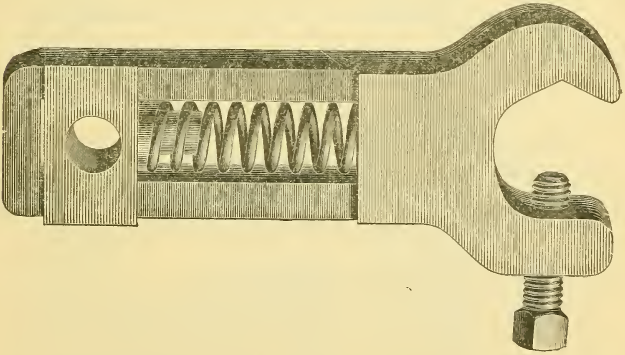
THE DURKIN THIN PLACE PREVENTER.

Durkin Thin Place Preventers are becoming important factors in the production of better goods, and many manufacturers consider them prime necessities. Although simple in construction, their use where light goods, i. e., goods of 70 picks to the inch or less are being woven, 1st:—Improves the quality of the goods materially; 2nd:—Increases the production of the loom; and 3rd:—Prevents waste of cloth.

Where Durkin Thin Place Preventers are used, smashes are hardly possible. Thick and thin places in the cloth are almost entirely done away with when the filling runs out. Better goods must necessarily result from their adoption. As it prevents a large percentage of breakage in the warp, it must of necessity help the production of the loom. In this latter respect alone they will soon save their cost.

We have letters highly commending the device from various manufacturers who are using it. Many tests have been made where the number of warp ends breaking back have been counted for a week on looms identical in every respect, except in one case the Preventers were on and in another off.

The breakages of ends in these tests have always been in favor of the looms with the Preventers on, and the least saving we know of has equaled 10 per cent. In some cases the saving has been as high as 50 per cent., and the tests have shown an average benefit of at least 25 per cent. in this respect.



The common forms of let-off motions are operated by the strain or pull of the warp over a "whip-roll" which forms one arm of a lever. The total length of slack which can be taken up by the leverage of the "whip-roll" is very little,—so little in fact that any interference with the take-up or let-off, or breaking of the filling without instantaneous stoppage of the loom, will make a thick or thin stripe which can be easily seen.

To increase the amount of slack in the warp, and at the same time maintain a proper tension on it, is necessary in order to prevent a smash when a shuttle is woven in.

By the Durkin Preventer both of these results are accomplished and a further control of the warp is gained when the loom is running, which must commend its action to any one when noticing its operation. This control is in regulating or equalizing the strain when the lay strikes and beats in the filling. The blow of the lay is equalized by the movement of the "whip-roll," which is supported in slotted stands at either end or side of the loom; in these slots are spiral springs of the proper tension for the kind of goods woven, compressible in the direction of the forward movement of the lay.

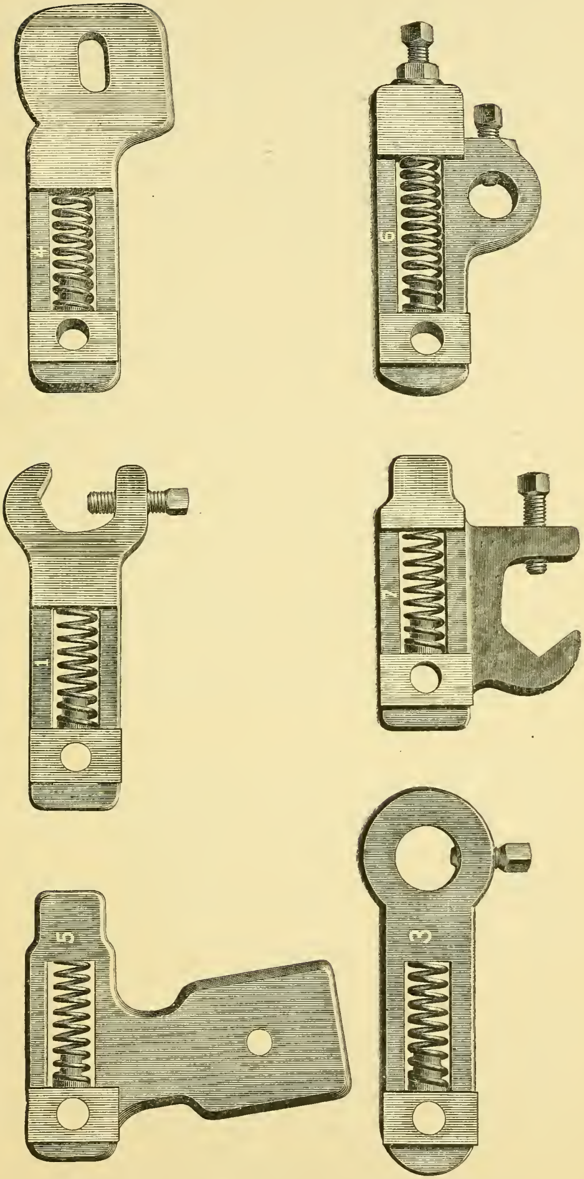
The compression of the springs is sufficient to allow the weaving in of a shuttle without a smash, and with the possibility of not a single end being broken. This may seem a strong statement, but a single trial will convince any one of its reliability; and a comparative inspection of the cloth from looms with the Preventer, with cloth from ordinary looms without it, will give most conclusive evidence of its value for preserving the evenness of the cloth and consequently enhancing its value by reducing the quantity of seconds, as well as by raising the standard of first quality.

We make patterns to fit any loom. Several are shown on the opposite page. Thousands have been sold in the last ten years.

COTTON CLOTH.

Ordinary cotton fabrics are either plain or twilled. In a plain weave there are warp and filling threads crossing each other at right angles and interweaving alternately. The thicker the threads, the larger will be the perforations. Such cloth is woven on the single shuttle loom with two harness, and is the simplest possible product.

In a twill weave a certain pattern is followed, made possible by enlarging the number of the harness. In plain weaving, each alternate end is a repetition, while in twill weaving the repetitions occur at longer intervals. A twill weave usually increases the bulk of the fabric, and of course offers opportunity for ornamentation. Apart from the variations produced by the harness, the cloth may be changed in appearance by the use of more than one warp, or more than one shuttle. Sep-



Different Shapes for Different Looms.

arate selvage motions are often used, and sometimes more than one thread is laid in the shed.

Many effects are produced after the cloth has left the loom, by methods of singeing, shearing, napping, brushing, steaming, moistening, sponging, shrinking, tentering, calendering, gumming, starching, glazing, embossing, watering and printing.

The following table shows the classes of goods produced in this country in the year 1890. It will be found that about two thirds of the cloth produced is simple two harness work.

PRODUCTS.	UNITED STATES.	
	Quantity.	Value.
Total value of all products		$267,981,724
Plain cloths for printing or converting (square yards).	955,294,320	43,550,174
Brown or bleached sheetings or shirtings (square yards).	962,238,062	55,193,439
Drills, twills, and sateens (square yards).	334,020,091	23,601,239
Ginghams (square yards)	268,996,715	20,686,390
Cotton flannels (square yards)	132,524,706	10,574,924
Fine or fancy woven fabrics (square yards)	127,373,179	12,545,929
Duck (square yards)	55,192,538	8,664,395
Ticks, denims, and stripes (square yards).	167,121,426	16,987,546
Upholstery goods		2,070,239
Bags or bagging		3,107,413
Tape and webbings		1,759,512
Yarns for sale (pounds)	166,397,003	33,247,596
Sewing cotton (pounds)	13,868,309	11,637,500
Twine (pounds)	8,533,730	1,364,300
Batting or wadding (pounds)	20,470,556	2,094,232
Rope (pounds)	3,590,228	479,415
Waste (pounds)	141,109,597	5,679,701
All other products		14,737,780

FAULTS IN CLOTH.

Faults at the loom arise from defects in warp or filling, and in parts of the mechanism that are defective in action. Warp defects are caused by warp threads breaking and not being promptly repaired, also by certain threads being slack on the beam which, when present in large quantity, can seriously affect the face of the cloth. In the common loom warp breakages have been treated as unavoidable, and the trade has been taught to expect defects made by threads breaking and not being immediately pieced in. The later processes tend to hide these defects, but often they are so marked as to class the goods as seconds.

With our Northrop loom such defects are practically cured by the warp stop motion. This also prevents the formation of "floats" when they are caused by the tangling of broken warp threads, which keep either shed out of position in such manner as to allow the shuttle to pass over or under the wrong threads. This defect is so serious on common looms as to necessitate a pick-out unless occurring with very few threads. Bunches of lint, or waste, can also cause floats by dropping in between the sheds back of the reed.

Filling defects have several causes. The shuttle tension may not be sufficient, causing crinkles or loops; the filling may weave off in several layers at once, making a very unsightly fault. This is usually due to having the builder motion wrong on the cop or bobbin, as a good, hard wind with not too slow traverse, rarely acts in this manner.

The weaver on the common loom may not insert the shuttle at the point where the filling was exhausted, or the loom may not have stopped promptly so that the shuttle will be put in the wrong shed where more than two harnesses are used. This makes a miss-pick which is serious on goods that are to be napped, or where the pattern is prominent. Many mills, however, ignore this requirement in the weave room, although they may be very strict about it in theory. Unless the goods are very closely inspected, it is hard to keep the weavers up to the mark on this point.

A poor face on the goods may be caused by improper setting of the whip-roll, slackness in the harness, late treading or picking, uneven sheds, or improper adjustment of let-off. The amount of twist in the filling also affects the face, and certain relative positions of breast beam and lay can sometimes be made to show effects in the surface. Thick and thin places are due to improper adjustment of let-off or take-up, or improper selection of style of let-off or take-up. Thin places usually come where the filling is changed, and the thin place is usually followed by a thick place. Of course if any parts of the loom are loose or worn badly, the results are naturally worse. Reedy cloth is due to bent or damaged reeds, and an improper shape of harness cam can also produce a similar appearance. Bad selvages are due to lack of sufficient selvage ends, or to poor setting or selection of temples. The set of the pick can also affect them. It is of course understood that certain temples work well on some goods that are not at all efficient on others.

Smashes come from catching the shuttle in the warp when beating up the reed. The protectors are not always in order, and on some looms the cloth woven is so wide that the binder does not protect quick enough, allowing the point of the shuttle to be in the warp and make a smash when the protector is all right. The only remedy for this latter defect is to lengthen the lay, or weave the cloth on a wider loom. It would be wrong to attempt to cure this fault by having the swell of the binder nearer the lay end, if it could not then properly slow the shuttle.

Warp breakage is often caused by splinters or rough places on the shuttle itself, and great care should be taken to keep them smooth. Shuttles should be frequently oiled, as that will tend to lengthen their wear.

PRINT WORKS IN THE UNITED STATES.

	Name of Print Works.	Location.
1	Algonquin	Fall River, Mass.
2	Allen	Providence, R. I.
3	American	Fall River, Mass.
4	Arnold	North Adams, Mass.
5	Clyde	River Point, R. I.
6	Cocheco Mfg. Co.	Dover, N. H.
7	Cochran Tky. Rd. Wk.	Malden, Mass.
8	Dunnell Mfg. Co.	Pawtucket, R. I.
9	Eddystone	Chester, Penn.
10	Gardner & Co.	Haverstraw, N. Y.
11	" "	Wappinger Falls, N. Y.
12	Gloucester	Gloucester, N. J.
13	Hamilton Mfg. Co.	Lowell, Mass.
14	Manchester Mills	Manchester, N. H.
15	Merrimack Mfg. Co.	Lowell, Mass.
16	Mystic	Medford, Mass.
17	Pacific Mills	Lawrence, Mass.
18	Passaic	Passaic, N. J.
19	Southbridge	Southbridge, Mass.
20	Windsor	North Adams, Mass.

RULES AND INFORMATION FOR WEAVERS.

For numbering yarns see pages 96-107.

To find the number of yards of cloth to the pound avoirdupois:

Multiply its width in inches by the weight in grains of a piece containing 1 square inch; divide 194.44 by the product and the quotient will be the number of yards to the pound. *Example:* Width of cloth, 30 inches; weight of 1 square inch, 1.5 grains. $\frac{194.44}{30\times1.5}=4.32$ yards per pound.

To find the average number of yarn required to produce cloth of any desired weight, width, and pick:

Add together the number of picks per inch of warp and filling; multiply their sum by the yards of cloth per pound, and this product by the width in inches; divide by 840, and the quotient will be the average number of yarn required. For any increase in weight by sizing, proportional allowance must be made in the yarn.

N. B.—As the filling is taken up in crossing the warp, and the amount varies in different goods, this rule is not exact, but will approximate near enough to furnish a basis for practical purposes.

Weight of a square yard of cloth when the weight of a square inch is given;

Weight of sq. in. in grains.	1	2	3	4	5	6	7
Weight of sq. yd. in lbs.	.1851	.3703	.5554	.7406	.9257	1.1109	1.2961

To find the size of warp of filling in any piece of goods;

Take 8 or more threads of any known number, say 2 feet long, and tie the ends together; this makes a link, through which draw the same number of threads of the same length of the unknown number, and twist the two links thus made as you would twist a chain. A keen eye will detect any difference in the size of the two links. By adding to or taking from either link, they can be varied in size in proportion to the number of threads used, and brought to nearly equal each other. When as nearly as possible alike, the unknown number can be approximately determined by the proportionate number of strands in each link. Thus, if 28 is the known number, and if 7 strands of the unknown make an equal size link of 8 strands of the known, the number of the unknown will be $\frac{7}{8}$ of 28=24.5.

Cotton cloth is sold on a basis of a certain number of yards to the pound, with a certain number of picks or threads per inch in warp and filling.

Standard print cloths weigh seven yards to the pound, have 64 picks of warp and filling to the inch, and are called 64×64—seven-yard goods.

Loom reeds are numbered by the number of dents or splits to the inch.

The number of threads in a warp divided by the number of the reed multiplied by the width in inches, will give the number of threads in a dent.

Linens take their technical fineness from the number of hundred dents or splits in a loom reed thirty-seven inches wide. There are two threads to each dent. The following table, adapted from Barlow's "History of Weaving," gives the number of threads to the inch for each "count" of linen goods:

Hundreds.	Threads per inch.	Hundreds.	Threads per inch.	Hundreds.	Threads per inch.	Hundreds.	Threads per inch.
5 00	27.03	12 00	64.86	19 00	102.7	26 00	140.5
6 00	32.43	13 00	70.27	20 00	108.1	27 00	145.9
7 00	37.84	14 00	75.68	21 00	113.5	28 00	151.4
8 00	43.24	15 00	81.08	22 00	118.9	29 00	156.8
9 00	48.65	16 00	86.49	23 00	124.3	30 00	162.2
10 00	54.05	17 00	91.89	24 00	129.7	31 00	167.6
11 00	59.46	18 00	97.30	25 00	135.1	32 00	173.0

Weight of warp or filling in one square yard:

The tables on pages 227-230 give the weight in decimals of a pound of the quantity of common warp and weft or filling in one square yard of cloth for any number of yarn, from five to one hundred, and for any number of picks per inch from twenty to one hundred and eighty. Multiply the weight given in the tables by .525 for woolen, 1.5 for worsted, 2.8 for linen and .525 for silk, if the number of the silk represents the number of hundred yards per ounce.

Both warp and filling take up in weaving, by passing over and under alternate threads; therefore, one yard of warp or filling will fall a percentage short of making a yard of cloth. This percentage varies with each different size of yarn and number of picks per inch, and for other reasons; consequently, the tables have been made, giving the weights of straight yarn, to which must be added the take-up or shrinkage, to obtain the precise weight of a yard of cloth. It may be safe to say that from seven to eight per cent. is an average shrinkage on cotton goods. On some woolen cloths, the finishing processes reduce the weight so that the calculated weights are as near as may be to the weight of the finished goods.

Yarn is commonly numbered before it is slashed or sized, and in estimating the weight of finished cloth, the quantity of sizing added to the warp must be known.

Production in yards of a loom running constantly for ten hours:

The tables on pages 231—232 give the number of yards of cloth which can be woven per loom in one day of ten hours, if the loom runs constantly. If the quantity given in the tables is exceeded in the production of any loom, it shows that an error has been made in estimating the number of picks per inch or in the speed of the loom. Of course, the same errors might account for a falling *short* of the quantities in the table; but as no loom runs constantly, the difference between the actual production and the possible production, represents the quantity that might be woven during the time that the loom is stopped. The percentage of time of stoppage of a loom can be ascertained by dividing this difference by the possible production.

The tables giving the pounds of Cotton Warp or Filling in one square yard were prepared by Mr. Richards of the Maginnis Mills in New Orleans. Credit should have been given in our former edition.

No. of yarn.	Picks per inch.									
	20	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
5	.171	.180	.189	.197	.206	.214	.223	.231	.240	.249
6	.143	.150	.157	.164	.171	.179	.186	.193	.200	.207
7	.122	.129	.135	.141	.147	.153	.159	.165	.171	.178
8	.107	.112	.118	.123	.129	.134	.139	.145	.150	.155
9	.095	.100	.105	.110	.114	.119	.124	.129	.133	.138
10	.036	.090	.094	.099	.103	.107	.111	.116	.120	.124
11	.078	.082	.086	.090	.094	.097	.101	.105	.109	.113
12	.071	.075	.079	.082	.086	.089	.093	.096	.100	.104
13	.066	.069	.073	.076	.079	.082	.086	.089	.092	.096
14	.061	.064	.067	.070	.073	.077	.080	.083	.086	.089
15	.057	.060	.063	.066	.069	.071	.074	.077	.080	.083
16	.054	.056	.059	.062	.064	.067	.070	.072	.075	.078
17	.050	.053	.055	.058	.060	.063	.066	.068	.071	.073
18	.048	.050	.052	.055	.057	.060	.062	.064	.067	.069
19	.045	.047	.050	.052	.054	.056	.059	.061	.063	.065
20	.043	.045	.047	.049	.051	.054	.056	.058	.060	.062
21	.041	.043	.045	.047	.049	.051	.053	.055	.057	.059
22	.039	.041	.043	.045	.047	.049	.051	.053	.055	.056
23	.037	.039	.041	.043	.045	.047	.048	.050	.052	.054
24	.036	.037	.039	.041	.043	.045	.046	.048	.050	.052
25	.034	.036	.038	.039	.041	.043	.045	.046	.048	.050
26	.033	.035	.036	.038	.040	.041	.043	.045	.046	.048
27	.032	.033	.035	.037	.038	.040	.041	.043	.044	.046
28	.031	.032	.034	.035	.037	.038	.040	.041	.043	.044
29	.030	.031	.032	.034	.035	.037	.038	.040	.041	.043
30	.029	.030	.031	.033	.034	.036	.037	.039	.040	.041
31	.028	.029	.030	.032	.033	.035	.036	.037	.039	.040
32	.027	.028	.029	.031	.032	.033	.035	.036	.037	.039
33	.026	.027	.029	.030	.031	.032	.034	.035	.036	.038
34	.025	.026	.028	.029	.030	.032	.033	.034	.035	.037
35	.024	.026	.027	.028	.029	.031	.032	.033	.034	.036
36	.024	.025	.026	.027	.029	.030	.031	.032	.033	.035
37	.023	.024	.025	.027	.028	.029	.030	.031	.032	.034
38	.023	.024	.025	.026	.027	.028	.029	.030	.032	.033
39	.022	.023	.024	.025	.026	.027	.029	.030	.031	.032
40	.021	.022	.024	.025	.026	.027	.028	.029	.030	.031
	30	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**
5	.257	.266	.274	.283	.291	.300	.309	.317	.326	.334
6	.214	.221	.229	.236	.243	.250	.257	.264	.271	.279
7	.184	.190	.196	.202	.208	.214	.220	.227	.233	.239
8	.161	.166	.171	.177	.182	.187	.193	.197	.204	.209
9	.143	.148	.152	.157	.162	.167	.171	.176	.181	.186
10	.129	.133	.137	.141	.146	.150	.154	.159	.163	.167
11	.117	.121	.125	.129	.132	.136	.140	.144	.148	.152
12	.107	.111	.114	.118	.121	.125	.129	.132	.136	.139
13	.099	.102	.105	.109	.112	.115	.119	.122	.125	.129
14	.092	.095	.098	.101	.104	.107	.110	.113	.116	.119
15	.086	.089	.091	.094	.097	.100	.103	.106	.109	.111
16	.080	.083	.086	.088	.091	.094	.096	.099	.102	.104
17	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098
18	.071	.074	.076	.079	.081	.083	.086	.088	.090	.093
19	.068	.070	.072	.074	.077	.079	.081	.083	.086	.088
20	.064	.066	.069	.071	.073	.075	.077	.079	.081	.084
21	.061	.063	.065	.067	.069	.071	.073	.076	.078	.080
22	.058	.060	.062	.064	.066	.068	.070	.072	.074	.076
23	.056	.058	.060	.061	.063	.065	.067	.069	.071	.073
24	.054	.055	.057	.059	.061	.062	.064	.066	.068	.070
25	.051	.053	.055	.057	.058	.060	.062	.063	.065	.067
26	.049	.051	.053	.054	.056	.058	.059	.061	.063	.064
27	.048	.049	.051	.052	.054	.056	.057	.059	.060	.062
28	.046	.047	.049	.051	.052	.054	.055	.057	.058	.060
29	.044	.046	.047	.049	.050	.052	.053	.055	.056	.058
30	.043	.044	.046	.047	.049	.050	.051	.053	.054	.056
31	.041	.043	.044	.046	.047	.048	.050	.051	.052	.054
32	.040	.042	.043	.044	.046	.047	.048	.050	.051	.052
33	.039	.040	.042	.043	.044	.045	.047	.048	.049	.051
34	.038	.039	.040	.042	.043	.044	.045	.047	.048	.049
35	.037	.038	.039	.040	.042	.043	.044	.045	.046	.048
36	.036	.037	.038	.039	.040	.042	.043	.044	.045	.046
37	.035	.036	.037	.038	.039	.041	.042	.043	.044	.045
38	.034	.035	.036	.037	.038	.039	.041	.042	.043	.044
39	.033	.034	.035	.036	.037	.038	.040	.041	.042	.043
40	.032	.033	.034	.035	.036	.037	.039	.040	.041	.042

No. of yarn	Picks per inch.									
	40	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**
10	.171	.176	.180	.184	.189	.193	.197	.201	.206	.210
11	.156	.160	.164	.168	.171	.175	.179	.183	.187	.191
12	.143	.146	.150	.154	.157	.161	.164	.168	.171	.175
13	.132	.135	.138	.142	.145	.148	.152	.155	.158	.162
14	.122	.126	.129	.132	.135	.138	.141	.144	.147	.150
15	.114	.117	.120	.123	.126	.129	.131	.134	.137	.140
16	.107	.110	.112	.115	.118	.121	.123	.126	.129	.131
17	.101	.103	.106	.108	.111	.113	.116	.118	.121	.124
18	.095	.098	.100	.102	.105	.107	.110	.112	.114	.117
19	.090	.092	.095	.097	.099	.102	.104	.106	.168	.110
20	.086	.088	.090	.092	.094	.096	.099	.101	.103	.105
21	.082	.084	.086	.088	.090	.092	.094	.096	.098	.100
22	.078	.080	.082	.084	.086	.088	.090	.092	.094	.095
23	.075	.076	.078	.080	.082	.084	.086	.088	.089	.091
24	.071	.073	.075	.077	.079	.080	.082	.084	.086	.087
25	.069	.070	.072	.074	.075	.077	.079	.081	.082	.084
26	.066	.068	.069	.071	.073	.074	.076	.077	.079	.081
27	.063	.065	.067	.068	.070	.071	.073	.075	.076	.078
28	.061	.063	.064	.066	.067	.069	.070	.072	.073	.075
29	.059	.061	.062	.064	.065	.067	.068	.069	.071	.072
30	.057	.059	.060	.061	.063	.064	.066	.067	.069	.070
31	.055	.057	.058	.059	.061	.062	.064	.065	.066	.068
32	.054	.055	.056	.058	.059	.060	.062	.063	.064	.066
33	.052	.053	.055	.056	.057	.058	.060	.061	.062	.064
34	.050	.052	.053	.054	.055	.057	.058	.059	.061	.062
35	.049	.050	.051	.053	.054	.055	.056	.058	.059	.060
36	.048	.049	.050	.051	.052	.054	.055	.056	.057	.058
37	.046	.047	.049	.050	.051	.052	.053	.054	.056	.057
38	.045	.046	.047	.048	.050	.051	.052	.053	.054	.055
39	.044	.045	.046	.047	.048	.049	.051	.052	.053	.054
40	.043	.044	.045	.046	.047	.048	.049	.050	.051	.052
41	.042	.043	.044	.045	.046	.047	.048	.049	.050	.051
42	.041	.042	.043	.044	.045	.046	.047	.048	.049	.050
43	.040	.041	.042	.043	.044	.045	.046	.047	.048	.049
44	.039	.040	.041	.042	.043	.044	.045	.046	.047	.048
45	.038	.039	.040	.041	.042	.043	.044	.045	.046	.047
	50	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**
10	.214	.219	.223	.227	.231	.236	.240	.244	.249	.253
11	.195	.199	.203	.206	.210	.214	.218	.222	.226	.230
12	.179	.182	.186	.189	.193	.196	.200	.204	.207	.211
13	.165	.168	.171	.175	.178	.181	.185	.188	.191	.195
14	.153	.156	.159	.162	.165	.168	.171	.174	.178	.181
15	.143	.146	.149	.151	.154	.157	.160	.163	.166	.169
16	.134	.137	.139	.142	.145	.147	.150	.153	.155	.158
17	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149
18	.119	.121	.124	.126	.129	.131	.133	.136	.138	.140
19	.113	.115	.117	.120	.122	.124	.126	.129	.131	.133
20	.107	.109	.111	.114	.116	.118	.120	.122	.124	.126
21	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120
22	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115
23	.093	.095	.097	.099	.101	.102	.104	.106	.108	.110
24	.089	.091	.093	.095	.096	.098	.100	.102	.104	.105
25	.086	.087	.089	.091	.093	.094	.096	.098	.099	.101
26	.082	.084	.086	.087	.089	.091	.092	.094	.096	.097
27	.079	.081	.083	.084	.086	.087	.089	.090	.092	.094
28	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090
29	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087
30	.071	.073	.074	.076	.077	.079	.080	.081	.083	.084
31	.069	.071	.072	.073	.075	.076	.077	.079	.080	.082
32	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079
33	.065	.066	.068	.069	.070	.071	.073	.074	.075	.077
34	.063	.064	.066	.067	.068	.069	.071	.072	.073	.074
35	.061	.062	.064	.065	.066	.067	.069	.070	.071	.072
36	.060	.061	.062	.063	.064	.065	.067	.068	.069	.070
37	.058	.059	.060	.061	.063	.064	.065	.066	.067	.068
38	.056	.058	.059	.060	.061	.062	.063	.064	.065	.067
39	.055	.056	.057	.058	.059	.060	.062	.063	.064	.065
40	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063
41	.052	.053	.054	.055	.056	.057	.059	.060	.061	.062
42	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060
43	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059
44	.049	.050	.051	.052	.053	.054	.055	.056	.056	.057
45	.048	.049	.050	.050	.051	.052	.053	.054	.055	.056

Pounds of Cotton Warp or Filling in one square yard.

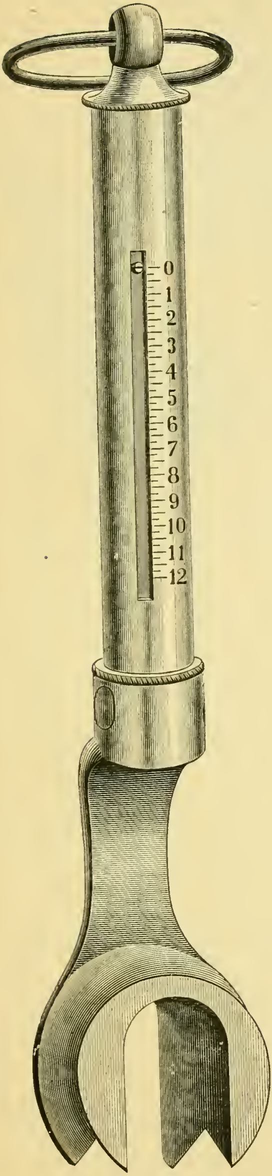
No. of yarn.	Picks per inch.										
	60	62	64	66	68	70	72	74	76	78	80
15	.171	.177	.183	.189	.194	.200	.206	.211	.217	.223	.229
16	.161	.166	171	.177	.182	.187	.193	.197	.204	.209	.214
17	.151	.156	.161	.166	.171	.176	.182	.187	.192	.197	.202
18	.143	.148	.152	.157	.162	.167	.171	.176	.181	.186	.190
19	.135	.140	.144	.149	.153	.158	.162	.167	.171	.176	.180
20	.129	.133	.137	.141	.146	.150	.154	.159	.163	.167	.171
21	.122	.127	.131	.135	.139	.143	.147	.151	.155	.159	.163
22	117	.121	.125	.129	.132	.136	.140	.144	.148	.152	.156
23	.112	.116	.119	.123	.127	.130	.134	.138	.142	.145	.149
24	.107	.111	.114	.118	.121	.125	.129	.132	.136	.139	.143
25	.103	.106	.110	.113	.117	.120	.123	.127	.130	.134	.137
26	.099	.102	.105	.109	.112	.115	.119	.122	.125	.129	.132
27	.095	.098	.102	.105	.108	.111	.114	.117	.121	.124	.127
28	.092	.095	.098	.101	.104	.107	.110	.113	.116	.119	.122
29	089	.092	.095	.098	.100	.103	.106	.109	.112	.115	.118
30	.086	.089	.091	.094	.097	.100	.103	.106	.109	.111	.114
31	083	.086	.088	.091	.094	.097	.100	.102	.105	.108	.111
32	.080	.083	.086	.088	.091	.094	.096	.099	.102	.104	.107
33	.078	.081	.083	.086	.088	.091	.094	.096	.099	.101	.104
34	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098	.101
35	.073	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098
36	071	.074	.076	.079	.081	.083	.086	.088	.090	.093	.095
37	.069	.072	.074	.076	.079	.081	.083	.086	.088	.090	.093
38	.068	.070	.072	.074	.077	.079	.081	.083	.086	.088	.090
39	.066	.068	.070	.073	.075	.077	.079	.081	.084	.086	.088
40	.064	.066	.069	.071	.073	.075	.077	.079	.081	.084	.086
41	.063	.065	.067	.069	.071	.073	.075	.077	.079	.082	.084
42	.061	.063	.065	.067	.069	.071	.073	.076	.078	.080	.082
43	.060	.062	.064	.066	.068	.070	.072	.074	.076	.078	.080
44	.058	.060	.062	.064	.066	.068	.070	.072	.074	.076	.078
45	.057	.059	.061	.063	.065	.067	.069	.070	.072	.074	.076
46	.056	.058	.060	.061	.063	.065	.067	.069	.071	.073	.075
47	.055	.057	.058	.060	.062	.064	.066	.067	.069	.071	.073
48	.054	.055	.057	059	.061	.062	.064	.066	.068	.070	.071
49	.052	.054	.056	.058	.059	.061	.063	.065	.066	.068	.070
50	.051	.053	.055	.057	.058	.060	.062	.063	.065	.067	.069
	80	82	84	86	88	90	92	94	96	98	100
20	.171	.176	.180	.184	.189	.193	.197	.201	.206	.210	.214
21	.163	.167	.171	.176	.180	.184	.188	.192	.196	.200	.204
22	.156	.160	.164	.168	.171	175	.179	.183	.187	.191	.195
23	.149	.153	.157	.160	.164	.168	.171	.175	.179	.183	.186
24	.143	.146	.150	.154	.157	.161	.164	.168	.171	.175	.179
25	137	.141	.144	.147	.151	.154	.158	.161	.165	.168	.171
26	.132	.135	.138	.142	.145	.148	.152	.155	.158	.162	.165
27	.127	.130	.133	.137	.140	.143	.146	.149	.152	.156	.159
28	.122	.126	.129	.132	.135	.138	.141	.144	.147	.150	.153
29	.118	.121	.124	.127	.130	.133	.136	.139	.142	.145	.148
30	.114	.117	.120	.123	.126	.129	.131	.134	.137	.140	.143
31	.111	.113	.116	.119	.122	.124	.127	.130	.133	.135	.138
32	.107	.110	.112	.115	.118	.121	.123	.126	.129	.131	.134
33	.104	.107	.109	.112	.114	.117	.119	.122	.125	.127	.130
34	.101	.103	.106	.108	.111	.113	.116	.118	.121	.124	.126
35	.098	.100	.103	.105	.108	.110	.113	.115	.118	.120	.122
36	.095	.098	.100	.102	.105	.107	.110	.112	.114	.117	.119
37	.093	.095	.097	.100	.102	.104	.107	.109	.111	114	.116
38	.090	.092	.095	.097	.099	.102	.104	.106	.108	.110	.113
39	.088	.090	.092	.095	.097	.099	.101	.103	.105	.107	.110
40	.086	.088	.090	.092	.094	.096	.099	.101	.103	.105	.107
41	.084	.086	.088	.090	.092	.094	.096	.098	.100	.102	105
42	.082	.084	.086	.088	.090	.092	.094	.096	.098	.100	.102
43	.080	.082	.084	.086	.088	.090	.092	.094	.096	.098	.100
44	.078	.080	.082	.084	.086	.088	.090	.092	.094	.095	.097
45	.076	.078	.080	.082	.084	.086	.088	.090	.091	.093	.095
46	.075	.076	.078	.080	.082	.084	.086	.088	.089	.091	.093
47	.073	.075	.077	.078	.080	.082	.084	.086	.088	.089	.091
48	.071	.073	.075	.077	.079	.080	.082	.084	.086	.087	.089
49	.070	.072	.073	.075	.077	.079	.080	.082	.084	.086	.087
50	.069	.070	.072	.074	.075	.077	.079	.081	.082	.084	.086
51	.067	069	.071	.072	.074	.076	.077	.079	.081	.082	.084
52	.066	.068	.069	.071	.073	.074	.076	.077	.079	.081	.082
53	.065	.066	.068	.070	.071	.073	.074	.076	.078	.079	.081
54	.063	.065	.067	068	.070	.071	.073	.075	.076	.078	.079
55	.062	.064	.065	.067	.069	.070	.072	.073	.075	.076	.078

No. of yarn.	Picks per inch.										
	100	**102**	**104**	**106**	**108**	**110**	**112**	**114**	**116**	**118**	**120**
30	.143	.146	.149	.151	.154	.157	.160	.163	.166	.169	.171
31	.138	.141	.144	.147	.149	.152	.155	.158	.160	.163	.166
32	.134	.137	.139	.142	.145	.147	.150	.153	.155	.158	.161
33	.130	.133	.135	.138	.140	.143	.145	.148	.151	.153	.156
34	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149	.151
35	.122	.125	.127	.130	.132	.135	.137	.140	.142	.144	.147
36	.119	.121	.124	.126	.129	.131	.133	.136	.138	.140	.143
37	.116	.118	.120	.123	.125	.127	.130	.132	.134	.137	.139
38	.113	.115	.117	.120	.122	.124	.126	.129	.131	.133	.135
39	.110	.112	.114	.116	.119	.121	.123	.125	.127	.130	.132
40	.107	.109	.111	.114	.116	.118	.120	.122	.124	.126	.129
42	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122
44	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117
46	093	.095	.097	.099	.101	.102	.104	.106	.108	.110	.112
48	.089	.091	.093	.095	.096	.098	.100	.102	.104	.105	.107
50	.086	.087	.089	.091	.093	.094	.096	.098	.099	.101	.103
52	.082	.084	.086	.087	.089	.091	.092	.094	.096	.097	.099
54	.079	.081	.083	.084	.086	.087	.089	.090	.092	.094	.095
56	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090	.092
58	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087	.089
60	.071	.073	.074	.076	.077	.079	.080	.081	.083	.084	.086
62	.069	.071	.072	.073	.075	.076	.077	.079	.080	.082	.083
64	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079	.080
66	.065	.066	.068	.069	.070	.071	.073	.074	.075	.077	.078
68	.063	.064	.066	.067	068	.069	.071	.072	.073	.074	.076
70	.061	.062	.064	.065	.066	.067	.069	.070	.071	.072	.073
	120	**122**	**124**	**126**	**128**	**130**	**132**	**134**	**136**	**138**	**140**
40	.129	.131	.133	.135	.137	.139	.141	.144	.146	.148	.150
42	.122	.124	.127	.129	.131	.133	.135	.137	.139	.141	.143
44	.117	.119	.121	.123	.125	.127	.129	.131	.132	.134	.136
46	.112	.114	.116	.117	.119	.121	.123	.125	.127	.129	.130
48	.107	.109	.111	.112	.114	.116	.118	.120	.121	.123	.125
50	.103	.105	.106	.108	.110	.111	.113	.115	.117	.118	.120
52	.099	.101	.102	.104	.105	.107	.109	.110	.112	.114	.115
54	.095	.097	.098	.100	.102	.103	.105	.106	.108	.109	.111
56	.092	.093	.095	.096	.098	.099	.101	.103	.104	.106	.107
58	.089	.090	.092	.093	.095	.096	.098	.099	.100	.102	.103
60	.086	.087	.089	.090	.091	.093	.094	.096	.097	.099	.100
62	.083	.084	.086	.087	.088	.090	.091	.093	.094	.095	.097
64	.080	.082	.083	.084	.086	.087	.088	.090	.091	.092	.094
66	.078	.079	.081	.082	.083	.084	.086	.087	.088	.090	.091
68	.076	.077	.078	.079	.081	.082	.083	.084	.086	.087	.088
70	.073	.075	.076	.077	.078	.080	.081	.082	.083	.084	.086
72	.071	.073	.074	.075	.076	.077	.079	.080	.081	.082	.083
74	.069	.071	.072	.073	.074	.075	.076	.078	.079	.080	.081
76	.068	.069	.070	.071	.072	.073	.074	.076	.077	.078	.079
78	.066	.067	.068	.069	.070	.071	.073	.074	.075	.076	.077
80	.064	.065	.066	.067	.069	.070	.071	.072	.073	.074	.075
	140	**142**	**144**	**146**	**148**	**150**	**152**	**154**	**156**	**158**	**160**
50	.120	.122	.123	.125	.127	.129	.130	.132	.134	.135	.137
52	.115	.117	.119	.120	.122	.124	.125	.127	.129	.130	.132
54	.111	.113	.114	.116	.117	.119	.121	.122	.124	.125	.127
56	.107	.109	.110	.112	.113	.115	.116	.118	.119	.121	.122
58	.103	.105	.106	.108	.109	.111	.112	.114	.115	.117	.118
60	.100	.101	.103	.104	.106	.107	.109	.110	.111	.113	.114
65	.092	.094	.095	.096	.098	.099	.100	.102	.103	.104	.105
70	.086	.087	.088	.089	.091	.092	.093	.094	.096	.097	.098
75	.080	.081	.082	.083	.085	.086	.087	.088	.089	.090	.092
80	.075	.076	.077	.078	.079	.080	.081	.083	.084	.085	.086
85	.071	.072	073	.074	.075	.076	.077	.078	.079	.080	.081
	160	**162**	**164**	**166**	**168**	**170**	**172**	**174**	**176**	**178**	**180**
60	.114	.116	.117	.119	.120	.121	.123	.124	.126	.127	.129
65	.105	.106	.108	.109	.111	.112	.113	.115	.116	.117	.119
70	.098	.099	.100	.102	.103	.104	.105	.107	.108	.109	.110
75	.092	.093	.094	.095	.096	.097	.098	.099	.101	.102	.103
80	.086	.087	.088	.089	.090	.091	.092	.093	.094	.095	.096
85	.081	.082	.083	.084	.085	.086	.087	.088	.089	090	.091
90	.076	.077	.078	.079	.080	.081	.082	.083	.084	.085	.086
95	.072	.073	.074	.075	.076	.076	.077	.078	.079	.080	.081
100	.069	.070	.070	.071	.072	.073	074	.075	.075	.076	.077

Picks per inch.	Picks per minute.										
	100	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**
20	83.3	87.5	91.7	95.8	100.0	104.2	108.3	112.5	116.7	120.8	125.0
22	75.8	79.5	83.3	87.1	90.9	94.7	98.5	102.3	106.1	109.8	113.6
24	69.4	72.9	76.4	79.9	83.3	86.8	90.3	93.7	97.2	100.7	104.2
26	64.1	67.3	70.5	73.7	76.9	80.1	83.3	86.5	89.7	92.9	96.2
28	59.5	62.5	65.5	68.5	71.4	74.4	77.4	80.4	83.3	86.3	89.3
30	55.6	58.3	61.1	63.9	66.7	69.4	72.2	75.0	77.8	80.6	83.3
32	52.1	54.7	57.3	59.9	62.5	65.1	67.7	70.3	72.9	75.5	78.1
34	49.0	51.5	53.9	56.4	58.8	61.3	63.7	66.2	68.6	71.1	73.5
36	46.3	48.6	50.9	53.2	55.6	57.9	60.2	62.5	64.8	67.1	69.4
38	43.9	46.1	48.2	50.4	52.6	54.8	57.0	59.2	61.4	63.6	65.8
40	41.7	43.7	45.8	47.9	50.0	52.1	54.2	56.3	58.3	60.4	62.5
42	39.7	41.7	43.7	45.6	47.6	49.6	51.6	53.6	55.6	57.5	59.5
44	37.9	39.8	41.7	43.6	45.5	47.3	49.2	51.1	53.0	54.9	56.8
46	36.2	38.0	39.9	41.7	43.5	45.3	47.1	48.9	50.7	52.5	54.3
48	34.7	36.5	38.2	39.9	41.7	43.4	45.1	46.9	48.6	50.3	52.1
50	33.3	35.0	36.7	38.3	40.0	41.7	43.3	45.0	46.7	48.3	50.0
52	32.1	33.7	35.3	36.9	38.5	40.1	41.7	43.3	44.9	46.5	48.1
54	30.9	32.4	34.0	35.5	37.0	38.6	40.1	41.7	43.2	44.8	46.3
56	29.8	31.3	32.7	34.2	35.7	37.2	38.7	40.2	41.7	43.2	44.6
58	28.7	30.2	31.6	33.0	34.5	35.9	37.4	38.8	40.2	41.7	43.1
60	27.8	29.2	30.6	31.9	33.3	34.7	36.1	37.5	38.9	40.3	41.7
62	26.9	28.2	29.6	30.9	32.3	33.6	34.9	36.3	37.6	39.0	40.3
64	26.0	27.3	28.6	29.9	31.3	32.6	33.9	35.2	36.5	37.8	39.1
66	25.3	26.5	27.8	29.0	30.3	31.6	32.8	34.1	35.4	36.6	37.9
68	24.5	25.7	27.0	28.2	29.4	30.6	31.9	33.1	34.3	35.5	36.8
70	23.8	25.0	26.2	27.4	28.6	29.8	31.0	32.1	33.3	34.5	35.7
72	23.1	24.3	25.5	26.6	27.8	28.9	30.1	31.3	32.4	33.6	34.7
74	22.5	23.6	24.8	25.9	27.0	28.2	29.3	30.4	31.5	32.7	33.8
76	21.9	23.0	24.1	25.2	26.3	27.4	28.5	29.6	30.7	31.8	32.9
78	21.4	22.4	23.5	24.6	25.6	26.7	27.8	28.8	29.9	31.0	32.1
80	20.8	21.9	22.9	24.0	25.0	26.0	27.1	28.1	29.2	30.2	31.3
82	20.3	21.3	22.4	23.4	24.4	25.4	26.4	27.4	28.5	29.5	30.5
84	19.8	20.8	21.8	22.8	23.8	24.8	25.8	26.8	27.8	28.8	29.8
86	19.4	20.3	21.3	22.3	23.3	24.2	25.2	26.2	27.1	28.1	29.1
88	18.9	19.9	20.8	21.8	22.7	23.7	24.6	25.6	26.5	27.5	28.4
90	18.5	19.4	20.4	21.3	22.2	23.1	24.1	25.0	25.9	26.9	27.8
92	18.1	19.0	19.9	20.8	21.7	22.6	23.6	24.5	25.4	26.3	27.2
94	17.7	18.6	19.5	20.4	21.3	22.2	23.0	23.9	24.8	25 7	26.6
96	17.4	18.2	19.1	20.0	20.8	21.7	22.6	23.4	24.3	25.2	26.0
98	17.0	17.9	18.7	19.6	20.4	21.3	22.1	23.0	23.8	24.7	25.5
100	16.7	17.5	18.3	19.2	20.0	20.8	21.7	22.5	23.3	24.2	25.0
102	16.3	17.2	18.0	18.8	19.6	20.4	21.2	22.1	22.9	23.7	24.5
104	16.0	16.8	17.6	18.4	19.2	20.0	20.8	21.6	22.4	23.2	24.0
106	15.7	16.5	17.3	18.1	18.9	19.7	20.4	21.2	22.0	22.8	23.6
108	15.4	16.2	17.0	17.7	18.5	19.3	20.1	20.8	21.6	22.4	23.1
110	15.2	15.9	16.7	17.4	18.2	18.9	19.7	20.5	21.2	22.0	22.7
112	14.9	15.6	16.4	17.1	17.9	18.6	19.3	20.1	20.8	21.6	22.3
114	14.6	15.4	16.1	16.8	17.5	18.3	19.0	19.7	20.5	21.2	21.9
116	14.4	15.1	15.8	16.5	17.2	18.0	18.7	19.4	20.1	20.8	21.6
118	14.1	14.8	15.5	16.2	16.9	17.7	18.4	19.1	19.8	20.5	21.2
120	13.9	14.6	15.3	16.0	16.7	17.4	18.1	18.7	19.4	20.1	20.8
122	13.7	14.3	15.0	15.7	16.4	17.1	17.8	18.4	19.1	19.8	20.4
124	13.4	14.1	14.8	15.5	16.1	16.8	17.5	18.1	18.8	19.5	20.1
126	13.2	13.9	14.6	15.2	15.9	16.5	17.2	17.9	18.5	19.2	19.8
128	13.0	13.7	14.3	15.0	15.6	16.3	16.9	17.6	18.2	18.9	19.5
130	12.8	13.5	14.1	14.7	15.4	16.0	16.7	17.3	17.9	18.6	19.2
134	12.4	13.1	13.7	14.3	14.9	15.5	16.2	16.8	17.4	18.0	18.7
136	12.3	12.9	13.5	14.1	14 7	15.3	15.9	16.5	17.2	17.8	18.4
140	11.9	12.5	13.1	13.7	14.3	14 9	15.5	16.1	16.7	17.3	17.9
144	11.6	12.2	12.7	13.3	13.9	14.5	15.0	15.6	16.2	16.8	17.4
146	11.4	12.0	12.6	13.1	13 7	14.3	14.8	15.4	16.0	16.6	17.1
150	11.1	11.7	12.2	12.8	13.3	13.9	14.4	15.0	15.6	16.1	16.7
154	10.8	11.4	11.9	12.4	13.0	13.5	14.1	14.6	15.2	15.7	16.2
156	10.7	11.2	11.8	12.3	12.8	13.4	13.9	14.4	15.0	15.5	16.0
160	10.4	10.9	11.5	12.0	12.5	13.0	13.5	14.1	14.6	15.1	15.6
164	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2
166	10.0	10.5	11.0	11.5	12.0	12.6	13.1	13.5	14.1	14.6	15.1
170	9.8	10.3	10.8	11.3	11.8	12.3	12.7	13.2	13.7	14.2	14.7
174	9.6	10.1	10.5	11.0	11.5	12.0	12.5	12.9	13.4	13.9	14.4
176	9.5	9.9	10.4	10.9	11.4	11.8	12.3	12.8	13.3	13.7	14.2
180	9.3	9.7	10.2	10.6	11.1	11.6	12.0	12.5	13.0	13.4	13.9

Yards of Cloth per loom per day of ten hours.

Picks per inch.	Picks per minute.										
	155	**160**	**165**	**170**	**175**	**180**	**185**	**190**	**195**	**200**	**205**
20	129.2	133.3	137.5	141.7	145.8	150.0	154.2	158.3	162.5	166.7	170.8
22	117.4	121.2	125.0	128.8	132.6	136.4	140.2	143.9	147.7	151.5	155.3
24	107.6	111.1	114.6	118.1	121.5	125.0	128.5	131.9	135.4	138.9	142.4
26	99.4	102.6	105.8	109.0	112.2	115.4	118.6	121.8	125.0	128.2	131.4
28	92.3	95.2	98.2	101.2	104.2	107.1	110.1	113.1	116.1	119.0	122.0
30	86.1	88 9	91.7	94.4	97.2	100.0	102.8	105.5	108.3	111.1	113.9
32	80.7	83.3	85.9	88.5	91.1	93.7	96.4	99.0	101.6	104.2	106.8
34	76.0	78.4	80.9	83.3	85.8	88.2	90.7	93.1	95.6	98.0	100.5
36	71.8	74.1	76.4	78.7	81.0	83.3	85.6	88.0	90.3	92.6	94.9
38	68.0	70.2	72.4	74.6	76.8	78.9	81.1	83.3	85.5	87.7	89.9
40	64.6	66.7	68.7	70.8	72.9	75.0	77.1	79.2	81.3	83.3	85.4
42	61.5	63.5	65.5	67.5	69.4	71.4	73.4	75.4	77.4	79.4	81.3
44	58.7	60.6	62.5	64.4	66.3	68.2	70.1	72.0	73.9	75.8	77.7
46	56.2	58.0	59.8	61.6	63.4	65.2	67.0	68.8	70.7	72.5	74.3
48	53.8	55.6	57.3	59.0	60.8	62.5	64.2	66.0	67.7	69.4	71.2
50	51.7	53.3	55.0	56.7	58.3	60.0	61.7	63.3	65.0	66.7	68.3
52	49.7	51.3	52.9	54.5	56.1	57.7	59.3	60.9	62.5	64.1	65.7
54	47.8	49.4	50.9	52.5	54.0	55.6	57.1	58.6	60.2	61.7	63.3
56	46.1	47.6	49.1	50.6	52.1	53.6	55.1	56.5	58.0	59.5	61.0
58	44.5	46.0	47.4	48.8	50.3	51.7	53.2	54.6	56.0	57.5	58.9
60	43.1	44.4	45.8	47.2	48.6	50.0	51.4	52.8	54.2	55.6	56.9
62	41.7	43.0	44.4	45.7	47.0	48.4	49.7	51.1	52.4	53.8	55.1
64	40.4	41.7	43.0	44.3	45.6	46.9	48.2	49.5	50.8	52.1	53.4
66	39.1	40.4	41.7	42.9	44.2	45.5	46.7	48.0	49.2	50.5	51.8
68	38.0	39.2	40.4	41.7	42.9	44.1	45.3	46.6	47.8	49.0	50.2
70	36.9	38.1	39.3	40.5	41.7	42.9	44.0	45.2	46.4	47.6	48.8
72	35.9	37.0	38.2	39.4	40.5	41.7	42.8	44.0	45.1	46.3	47.5
74	34.9	36.0	37.2	38.3	39.4	40.5	41.7	42.8	43.9	45.0	46.2
76	34.0	35.1	36.2	37.3	38.4	39.5	40.6	41.7	42.8	43.9	45.0
78	33.1	34.2	35.3	36.3	37.4	38.5	39.5	40.6	41.7	42.7	43.8
80	32.3	33.3	34.4	35.4	36.5	37.5	38.5	39.6	40.6	41.7	42.7
82	31.5	32.5	33.5	34.6	35.6	36.6	37.6	38.6	39.6	40.7	41.7
84	30.8	31.7	32.7	33.7	34.7	35.7	36.6	37.7	38.7	39.7	40.7
86	30.0	31.0	32.0	32.9	33.9	34.9	35.8	36.8	37.8	38.8	39.7
88	29.4	30.3	31.3	32.2	33.1	34.1	35.0	36.0	36.9	37.9	38.8
90	28.7	29.6	30.6	31.5	32.4	33.3	34.3	35.2	36.1	37.0	38.0
92	28.1	29.0	29.9	30.8	31.7	32.6	33.5	34.4	35.3	36.2	37.1
94	27.5	28.4	29.3	30.1	31.0	31.9	32.8	33.7	34.6	35.5	36.3
96	26.9	27.8	28.6	29.5	30.4	31.3	32.1	33.0	33.9	34.7	35.6
98	26.4	27.2	28.1	28.9	29.8	30.6	31.5	32.3	33.2	34.0	34.9
100	25.8	26.7	27.5	28.3	29.2	30.0	30.8	31.7	32.5	33.3	34.4
102	25.3	26.1	27.0	27.8	28.6	29.4	30.2	31.0	31.9	32.7	33.5
104	24.8	25.6	26.4	27.2	28.0	28.8	29.6	30.4	31.3	32.1	32.9
106	24.4	25.2	25.9	26.7	27.5	28.3	29.1	29.9	30.7	31.4	32.2
108	23.9	24.7	25.5	26.2	27.0	27.8	28.5	29.3	30.1	30.9	31.6
110	23.5	24.2	25.0	25.8	26.5	27.3	28.0	28.8	29.5	30.3	31.1
112	23.1	23.8	24.6	25.3	26.0	26.8	27.5	28.3	29.0	29.8	30.5
114	22.7	23.4	24.1	24.9	25.6	26.3	27.0	27.8	28.5	29.2	30.0
116	22.3	23.0	23.7	24.4	25.1	25.9	26.6	27.3	28.0	28.7	29.5
118	21.9	22.6	23.3	24.0	24.7	25.4	26.1	26.8	27.5	28.2	29.0
120	21.5	22.2	22.9	23.6	24.3	25.0	25.7	26.4	27.1	27.8	28.5
122	21.2	21.9	22.5	23.2	23.9	24.6	25.3	26.0	26.6	27.3	28.0
124	20.8	21.5	22.2	22.8	23.5	24.2	24.9	25.5	26.2	26.9	27.6
126	20.5	21.2	21.8	22.5	23.1	23.8	24.5	25.1	25.8	26.5	27.1
128	20.2	20.8	21.5	22.1	22.8	23.4	24.1	24.7	25.4	26.0	26.7
130	19.9	20.5	21.2	21.8	22.4	23.1	23.7	24.4	25.0	25.6	26.3
134	19.3	19.9	20.5	21.1	21.8	22.4	23.0	23.6	24.3	24.9	25.5
136	19.0	19.6	20.2	20.8	21.4	22.1	22.7	23.3	23.9	24.5	25.1
140	18.5	19.0	19.6	20.2	20.8	21.4	22.0	22.6	23.2	23.8	24.4
144	17.9	18.5	19.1	19.7	20.3	20.8	21.4	22.0	22.6	23.1	23.7
146	17.7	18.3	18.8	19.4	20.0	20.5	21.1	21.7	22.3	22.8	23.4
150	17.2	17.8	18.3	18.9	19.4	20.0	20.6	21.1	21.7	22.2	22.8
154	16.8	17.3	17.9	18.4	18.9	19.5	20.0	20.6	21.1	21.6	22.2
156	16.6	17.1	17.6	18.2	18.7	19.2	19.8	20.3	20.8	21.4	21.9
160	16.1	16.7	17.2	17.7	18.2	18.7	19.3	19.8	20.3	20.8	21.4
164	15.8	16.3	16.8	17.3	17.8	18.3	18.8	19.3	19.8	20.3	20.8
166	15.6	16.1	16.6	17.1	17.6	18.1	18.6	19.1	19.6	20.1	20.6
170	15.2	15.7	16.2	16.7	17.2	17.6	18.1	18.6	19.1	19.6	20.1
174	14.8	15.4	15.8	16.3	16.8	17.2	17.7	18.2	18.7	19.2	19.6
176	14.7	15.2	15.6	16.1	16.6	17.0	17.5	18.0	18.5	18.9	19.4
180	14.4	14.8	15.3	15.7	16.2	16.7	17.1	17.6	18.1	18.5	19.0



BAND TENSION SCALES.

A Band Tension Scale is to the spinning room what an indicator is to the engine room. By its use, an intelligent overseer or second hand can save his wages (to the mill).

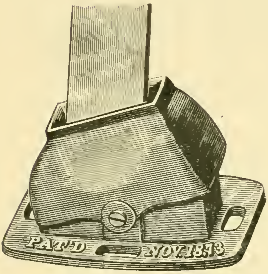
When we wish to be conservative, we call a horse power worth $30 a year. At this rate, it costs 30 cents a spindle per year for power under the most favorable conditions. If bands are too tight, 10 per cent. per spindle a year can easily be wasted. This scale can detect that loss, and is the only device of the kind to be found.

To use the scale, stop the frame, turn the spindle hooks, and then place the whorl of the scale under the spindle whorl, and slip the band from the spindle on to the scale whorl. By drawing the lower whorl, even with the spindle whorl, the tension is shown on the scale.

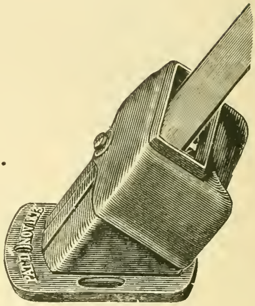
Frames can be run with intelligent oversight with an average band pull of 2 pounds. New bands should be put on to pull about 3 pounds.

When ordering send sample spindle blade with whorl attached.

WOOD'S BELT HOLE GUARDS.



For Straight Belts.



For Beveled Belts.

Wood's Patent Belt Hole Guards are desirable for the following reasons:—

1st. By the rotary movement of the covers the belt hole is much reduced in size, at least three quarters in cross belt holes. To illustrate, a two-inch cross belt requires a hole about four inches wide by its spread, say six to ten inches in length. These guards reduce the hole to about three fourths of an inch in width by about nine to ten inches in length, being a reduction in the size of the hole from thirty-two square inches to only six.

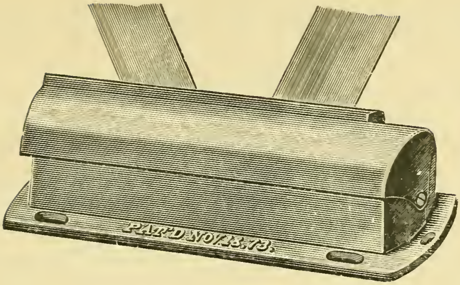
2d. The floor may be flooded, in case of fire, to the depth of two inches with no danger of the water running through the belt holes and injuring goods and machinery in the rooms below.

3d. In case of fire these guards prevent the flames from passing through the belt holes, either up or down, and are of the utmost importance in this particular.

4th. They prevent dirt, cotton, threads, waste, spools, and other articles from passing through the belt holes and damaging the cards or other machinery below.

5th. There is always a great quantity of imperceptible dust passing through the belt holes, following the current of air caused by the motion of the belt. These guards prevent that to a great extent.

6th. They very largely prevent the heat from passing from the lower to the upper room.

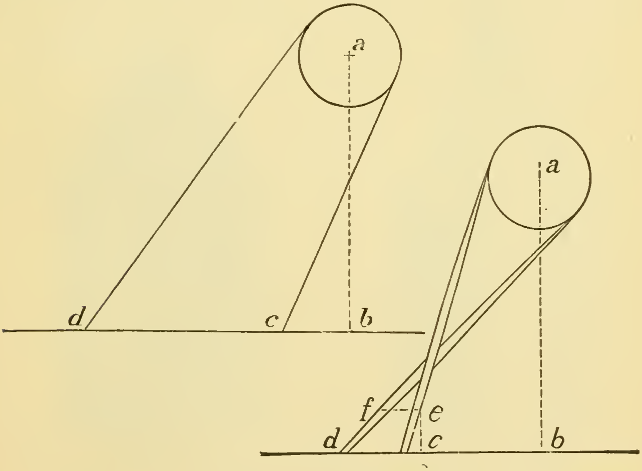

PAT'D NOV. 18. 73.

For Crossed Belts.

DIRECTIONS FOR ORDERING.

If care is used in following these directions much trouble will be saved. Reference to the accompanying diagrams will make the matter plain.

State number of machines for which guards are wanted. Give width of belt, diameter of pulley, WHOLE face of fast and loose pulleys, distance from floor to center of pulleys *a* to *b* in diagrams. And for



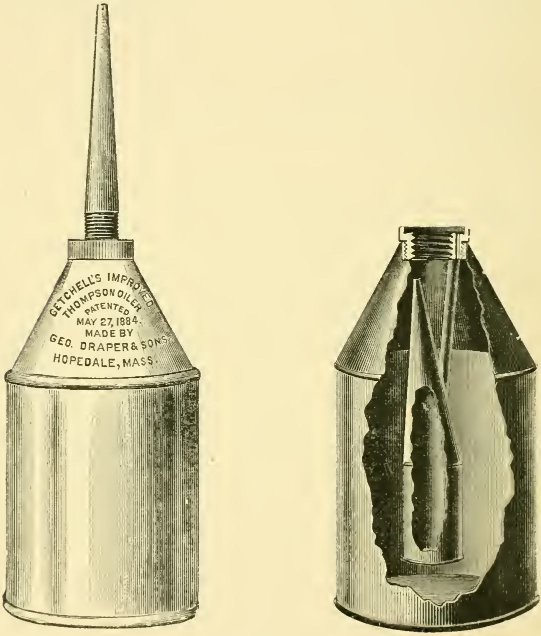
Straight Belts (see Fig. 1).—Give distance from *b* directly under center of pulley to each side of belt, or from *b* to *c*, and from *b* to *d*. If *b* comes between the two sides of belt, say so.

Cross Belts (see Fig. 2).—Give distance from *e* to *f* on line parallel with floor and three inches above it; also distance from *c* directly under *e* to *d*.

GETCHELL'S IMPROVED THOMPSON OIL-CAN.

We have been intimately connected with the manufacture of oil-cans for nearly forty years.

During the term of Thompson's patents we manufactured an oil-can that was not equalled for economy, convenience, and durability; and in introducing the improvement of a removable air-chamber and vent-tube with a case-hardened delivery-tube, we are confident that Getchell's Improved Thompson Can will lead all others that we have any knowledge of, by as great an advance as did the Thompson Can. No other oil-can has been sold in such quantities as the Thompson of our make.



Getchell's Oil-Can.

We stamp every can and guarantee it to be perfect.

Before concluding that a cheaper can is as good as ours, we ask for a trial in connection with any other in the market, feeling confident that our cans have no equal for economy in the use of oil, neatness and durability.

DIRECTIONS FOR ORDERING GETCHELL'S IMPROVED THOMPSON OIL-CANS.

Large . .	3¼ in. high,	2¾ in. diam.,	holding 3 gills.
Common .	3 " "	2½ " "	" 2 "
Small . .	2⅜ " "	2⅛ " "	" 1 "

We distinguish the tubes by the size of the holes: that is, No. 19 has a hole No. 19 wire-gauge; No. 20 has a hole No. 20 wire-gauge. Those most frequently wanted are Nos. 19, 20, and 21; but we make tubes with any size of hole to order.

Our common length of tube is 3¼ inches. Tubes of greater length we make to order.

Send for sample lot of cans.

ENGLISH LABOR.

American cotton mill laborers may be interested in a list of wages on the English scale, taken from "The Cotton Mill," published by Lancaster & Co. in 1892. We have changed the figures from pounds to dollars:

Card Room—		
Overseer,	$10.96	per week
Second hand,	7.23	"
Picker hands,	3.61	"
Large help,	4.00	"
Small help,	2.44	"
Spinning Room—		
Overseer,	9.74	"
Spinners,	3.23	"
Doffers,	1.62	"
Weave Room—		
Overseer,	14.61	"
Weavers, about	4.38	"
Fixers,	9.74	"
In General—		
Superintendent,	19.48	"
Book-keeper,	9.74	"
Clerk,	4.87	"
Engineer,	7.23	"
Fireman,	6.04	"
Mechanics,	7.23	"
Yard hands,	4.38	"

LANE TESTS.

During the summer of '95 when Gen. Draper was absent in Europe, we employed his secretary, Mr. Lane, in procuring records of actual results in cotton manufacture. He investigated three large Northern mills on prints and similar numbers, and we have tabulated his facts as follows. We do not name the mills for obvious reasons. It will be noticed that they vary in different departments. In some cases the single figures given are averaged from results that took weeks of observation. Six months continuous time was involved, and we trust the results will be of sufficient interest to warrant the expense:

CARDING.

	Revolving Flat Card, 3 Process Drawing.	Top Flat, Breaker & Finisher Cards, 2 Process Drawing.	Revolving Flat Card, 2 Process Drawing.
Production of cards per day in lbs	150	50	125
Weight of lap on card in lbs	44	44	46
Dia. of lap in inches	17	17	17
Width of lap in inches	40	34	40
Lap lasts (hours-minutes)	2-40	7-45	3-50
Dia. of can in front of card or Railway Head, in inches	9½	17½	11½
Length of can in inches	36	36	36
	Hrs. Min.	Hrs. Min.	Hrs. Min.
Card fills can in	27	....	51
Railway head fills can	....	20	
Coarse drawing empties can	2-34	2-	6-
Coarse drawing fills can	30	40 (15½ DIA. CAN.)	72
Intermediate drawing empties can	2-39		
Intermediate drawing fills can.	30		
Fine drawing empties can	3-03	2-15	5-56
Fine drawing fills can	35	29 (11½ DIA. CAN.)	77
Slubber empties can	3-35	4-24	6-31
Slubber fills bobbin	1-04	1-15	1-13
Intermediate empties bobbin	6-50	6-43	7-40
Intermediate fills bobbin	1-49	1-51	2-29
Fine frame empties bobbin	17-	17-	27-
Fine frame fills bobbin	3-17	2-52	4-49
DRAFTS—			
Railway head	....	4.	
Coarse drawing	5.21	3.62	4.75
Int. drawing	5.75		
Fine drawing	5.73	3.73	5.

CARDING.—Continued.

	Revolving Flat Card, 3 Process Drawing.	Top Flat, Breaker & Finisher Cards, 2 Process Drawing.	Revolving Flat Card, 2 Process Drawing.
Slubber	3.88	3.88	5.13
Intermediate	5.47	5.33	5.46
Fine	7.20	6.36	6.67
HANKS PER POUND—			
Front of card	.13		.16
" railway		.08	
" coarse drawing	.12	.10	.13
" intermediate "	.12		
" fine "	.12	.13	.10
Slubber	.44	.49	.54
Intermediate	1.22	1.27	1.55
Fine	4.45	3.97	5.00
SIZE OF ROVING BOBBIN—			
Slubber	6 x 12	Same.	Same.
Intermediate	4½ x 9	5 x 10	5 x 10
Fine	3½ x 7	Same.	Same.
NO. OF HANKS ON BOBBIN—			
Slubber	1.31	1.21	1.41
Intermediate	1.22	1.78	2.68
Fine	2.67	2.18	3.62
Roving is doubled on intermediate and fine frames in all cases.			
BREAKAGE OF ENDS—			
On card, per day	1¼	5-12	8 1-6
" coarse drawing	5	2	3
" intermediate drawing	1		
" fine	2	2	2
" 100 slubber spindles	48	79	137
" " intermediate "	49	34	50
" " fine "	39	28	19

SPINNING.

WARP FRAME.	Double Roving 1 5-8 Ring, 5 1-2 Traverse, No. 30.	Single Roving 1 5-8 Ring, 5 1-2 Traverse, No. 28.	Double Roving 1 3-4 Ring, 6 Traverse, No. 28.
Empties roving bobbin—hours	52-	25-	68-
Fills bobbin—hours-minutes	4-	3-49	6-
No. hanks on bobbin	2.49	2.94	3.42
Draft on frame	13.37	7.44	11.20
Breakage of ends per 100 spindles per day	41	63	118 new rings.

SPINNING.—Continued.

FILLING FRAME.	Single Roving, 1 1-4 Ring, No. 30.	Single Roving 1 5-16 ring, No. 36	Double Roving, 1 5-16 ring, No. 36.
Empties roving bobbin—hours-minutes	25-45	36-30	95-
Fills bobbin—hours-minutes	1-56	2-53	3-8
No. hanks on bobbin	1.56	1.82	1.56
Draft on frame	7.01	9.39	14.
Breakage of ends per 100 spindles per day	72	112	126 new rings.

MULE.		Single Roving, No. 36.	
Empties roving bobbin—hours		39-	
Fills cop—hours-minutes		2-40	
Hanks on cop		1.55	
Draft		9.27	
Breakage of ends per 100 spindles per day		167	

SPOOLING.

SPOOLER.	1 5-8 Ring, 5 1-2 Traverse.	1 5-8 Ring, 5 1-2 Traverse.	1 3-4 Ring, 6 Traverse.
Empties bobbin—minutes	9	11	18
No. bobbins on spool	11	11	7
Breakage of ends per 100 spindles per day	179	185	272

WARPING.

WARPER.			
Fills beam—hours-minutes	8-	8-30	8-45
No. yards on beam	24,000	24,000	21,000
Weight of beam—lbs	400	359	392
No. ends on beam	410	360	437
Breakage of ends per beam	32	36	32

SLASHING.

SLASHER.			
No. beams behind slasher	4	5	4
No. ends	1,784	1,800	1,760 16 twisted selvage ends.
Time to empty set of beams—hours-minutes	9-	10-	10-30
No. loom beams from set of warp beams	15	16	20
Cuts on loom beam	30	26	22
Yards per cut	48	54	46½
Distance between heads on loom beam	32	32	31½
Dia. of beam head	17	16	16

WEAVING.

LOOM.			
Production of looms per day in cuts	1.02	.96	1.04
Length of cuts—yards	48	54	46½
Breakage of warp ends per loom per day	22	29	14
Breakage of yarn on filling bobbins in weaving per loom per day	5	5	9
Thin stripes per cut	3	2	1
Warp runs over one inch—per cut	12	19	2

Next table is of Breaks and Replacements in three mills per thousand spindles per day. This shows operations necessary on each machine that require hand labor. Breaks signify parting of the sliver or yarn in its journey to the can, bobbin, cop, spool or beam. On the loom it signifies warp breaks or breaks of filling yarn.

Replacements signify the hand operations required to renew the laps on cards, the cans on drawing and slubber, the roving on roving and spinning frames, and the bobbins on the spoolers:

	Breaks.	Replacements.	Breaks.	Replacements.	Breaks.	Replacements.
*Card........	1.90	5.72	1.64	5.08	13.50	4.31
*Coarse drawing	6.18	32.17	1.49	19.46	5.17	22.41
*Int. "	1.29	29.60				
*Fine "	2.57	20.59	1.75	19.21	3.45	15.42
*Slubber........	4.40	25.60	7.67	20.48	12.57	12.20
*Intermediate.. ..	13.30	79.28	8.50	74.50	14.31	74.31
*Fine	46.82	141.66	30.60	128.96	27.74	108.03
Warp spinning..	410.	380.	630.	400.	1180.	300.
Filling " ..	720.	390.	1120.	270.	1260.	105.
Mule " ..	....	....	1670.	260.		
†Spooler........	105.29	3921.76	130.37	3914.73	176.28	2160.08
†Warper......	17.05	. ...	24.88	....	19.75	....
†Slasher	.07	....	.23	....	.09	....
*Loom........	565.99	....	839.61	....	398.29	....

†Figured per 1000 warp spindles.
*Figured on total number spindles.

We think it will pay any mill on similar numbers to take a test of their own machinery for comparison. There are some interesting deductions that can be made from these present tables. The large spinning ring and longer traverse evidently helps in doffing and spooling. The breakage of ends is greater, but we think this is due to new rings rather than to larger rings. The extra breakage on the spooler is quite perceptible, but is more than overcome by the extra time a bobbin runs. It will be seen that in the third mill the warps are evidently not wound hard on the slasher, as there are quite a few less cuts per beam. This third mill, however, has quite a perceptible diminution of warp breaks on the loom, which may come from this. This low breakage is also probably due somewhat to the larger warp bobbins, giving less knots at the spooler.

Table showing prices of Print Cloth and Cotton with margin for manufacturing cost and profit. Average of print cloth price is not exactly correct, as it is made by an average of yearly high and low prices rather than by average of daily prices.

YEAR	Highest Price of Print Cloth in Cents.	Lowest Price of Print Cloth in Cents.	Average of High and Low Price in Cents.	Price per Lb. in Cents, at 7 Yds. per Lb.	Average Price of Middling Uplands per Lb. in Cents.	Probable Cost per Lb. of Cotton Used in Cents, Allowing for 20 per cent. Waste.	Margin Between Cotton and Cloth in Cents per Lb.
1850	$5\frac{3}{4}$	5	$5\frac{3}{8}$	37.62	12.34	14.81	22.81
1851	$5\frac{1}{4}$	$4\frac{1}{4}$	$4\frac{3}{4}$	33.25	12.14	14.56	18.69
1852	$5\frac{3}{4}$	$4\frac{1}{4}$	5	35.	9.50	11.40	23.60
1853	$6\frac{3}{8}$	6	$6\frac{3}{16}$	43.31	11.02	13.22	30.09
1854	$6\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{7}{8}$	41.12	10.97	13.16	27.96
1855	$5\frac{1}{2}$	$4\frac{3}{4}$	$5\frac{1}{8}$	35.87	10.39	12.46	23.41
1856	$5\frac{3}{4}$	5	$5\frac{3}{8}$	37.62	10.30	12.36	25.26
1857	$6\frac{1}{8}$	$5\frac{7}{8}$	6	42.	13.51	16.21	25.79
1858	6	5	$5\frac{1}{2}$	38.50	12.23	14.67	23.83
1859	$5\frac{7}{8}$	$5\frac{1}{2}$	$5\frac{11}{16}$	39.81	12.08	14.49	25.32
1860	$5\frac{3}{4}$	$4\frac{7}{8}$	$5\frac{5}{16}$	37.18	11.	13.20	23.98
1861	9	$4\frac{1}{4}$	$6\frac{5}{8}$	46.37	13.01	15.61	30.76
1862	$14\frac{1}{2}$	7	$10\frac{3}{4}$	75.25	31.29	37.51	37.74
1863	19	$10\frac{3}{4}$	$14\frac{7}{8}$	104.12	67.21	80.65	23.47
1864	$38\frac{1}{2}$	$16\frac{1}{4}$	$27\frac{3}{8}$	191.37	101.50	121.80	69.57
1865	$27\frac{1}{4}$	10	$18\frac{5}{8}$	130.37	83.38	100.05	30.32
1866	$19\frac{1}{2}$	$11\frac{1}{4}$	$15\frac{3}{8}$	107.62	43.20	51.84	55.78
1867	12	$6\frac{5}{8}$	$9\frac{5}{16}$	65.18	31.59	37.90	27.28
1868	$9\frac{5}{8}$	$6\frac{1}{2}$	$8\frac{1}{16}$	56.43	24.85	29.82	26.61
1869	$9\frac{1}{2}$	$7\frac{1}{8}$	$8\frac{5}{16}$	58.18	29.01	34.81	23.37
1870	$8\frac{1}{4}$	$6\frac{1}{2}$	$7\frac{3}{8}$	51.62	23.98	28.77	22.85
1871	8	$6\frac{1}{2}$	$7\frac{1}{4}$	50.75	16.95	20.34	30.41
1872	9	$7\frac{3}{8}$	$8\frac{3}{16}$	57.31	20.48	24.57	32.74
1873	$7\frac{1}{2}$	$5\frac{3}{4}$	$6\frac{5}{8}$	46.37	18.15	21.78	24.59
1874	$6\frac{1}{8}$	$5\frac{1}{4}$	$5\frac{11}{16}$	39.81	17.	20.40	19.41
1875	$6\frac{3}{4}$	$4\frac{3}{8}$	$5\frac{9}{16}$	38.93	15.	18.	20.93
1876	$4\frac{7}{8}$	$3\frac{5}{8}$	$4\frac{1}{4}$	29.75	13.	15.60	14.15
1877	$5\frac{1}{4}$	$3\frac{5}{8}$	$4\frac{7}{16}$	31.06	11.73	14.07	16.99
1878	4	$3\frac{1}{8}$	$3\frac{9}{16}$	24.93	11.28	13.53	11.40
1879	$4\frac{1}{2}$	$3\frac{3}{16}$	$3\frac{27}{32}$	26.90	10.83	12.99	13.91
1880	$5\frac{87}{100}$	$3\frac{3}{4}$	$4\frac{81}{100}$	33.67	12.02	14.42	19.25
1881	$4\frac{1}{4}$	$3\frac{3}{4}$	4	28.	11.34	13.60	14.40
1882	$3\frac{95}{100}$	$3\frac{5}{8}$	$3\frac{78}{100}$	26.46	12.16	14.59	11.87
1883	$3\frac{13}{16}$	$3\frac{44}{100}$	$3\frac{64}{100}$	25.48	10.63	12.75	12.73
1884	$3\frac{62}{100}$	$3\frac{8}{100}$	$3\frac{35}{100}$	23.45	10.64	12.76	10.69
1885	$3\frac{1}{4}$	$2\frac{98}{100}$	$3\frac{11}{100}$	21.77	10.54	12.64	9.13
1886	$3\frac{1}{2}$	$3\frac{1}{8}$	$3\frac{5}{16}$	23.18	9.44	11.32	11.86
1887	$3\frac{5}{8}$	$3\frac{1}{4}$	$3\frac{7}{16}$	24.06	10.25	12.30	11.76
1888	4	$3\frac{1}{2}$	$3\frac{3}{4}$	26.25	10.27	12.32	13.93
1889	$4\frac{1}{16}$	$3\frac{1}{2}$	$3\frac{25}{32}$	26.46	10.71	12.85	13.61
1890	$3\frac{9}{16}$	3	$3\frac{9}{32}$	22.96	11.53	13.83	9.13
1891	$3\frac{1}{16}$	$2\frac{3}{4}$	$2\frac{29}{32}$	20.34	9.03	10.83	9.51
1892	$4\frac{1}{16}$	$3\frac{1}{16}$	$3\frac{9}{16}$	24.93	7.64	9.16	13.77
1893	4	$2\frac{3}{4}$	$3\frac{3}{8}$	23.62	8.24	9.88	13.74
1894	3	$2\frac{1}{2}$	$2\frac{3}{4}$	19.25	7.67	9.20	10.05
1895	$3\frac{5}{16}$	$2\frac{7}{16}$	$2\frac{7}{8}$	20.12	6.62	7.94	12.18

Some years since Mr. F. P. Sheldon prepared some figures on costs for the New England Cotton Manufacturer's Association, which we take the liberty of printing below. It must be remembered in using this for a basis of comparison, that wages vary in different periods:

COST PER YEAR OF OPERATING ONE SPINDLE ON PRINT CLOTH NUMBERS.

	A.	B.	C.	D.	E.	F.
	Power. Cents.	Labor. Cents.	Interest and Depreciation. Cents.	Totals.	Production. Pounds.	Resultant Cost per 100 Pounds.
Mules, slow speed (1869)	9½	64	34	$1.07	39	$2.75
Modern mules, high speed	11 to 16	64	34	1.09 to $1.14	46	2.39 to $2.48
Warp frames, old, 6000 revolutions	24	58	44	1.26	46	2.74
Sawyer frames, 7500 revolutions	17	58	44	1.19	56	2.12
Modern frames, 9200 revolutions	24	59	44	1.27	69	1.84

Supplies not included, except fuel for power.

TO INVENTORS.

Many bright men employed around cotton mills conceive new ideas, which are more or less valuable. We have had more experience with such inventors and inventions than any other firm. While we as yet only care for patents on certain lines. we are always ready to look at any inventions in cotton machinery, and give our opinion of them.

Remember that an invention is of commercial value in proportion to the profit accruing to the manufacturer by its use.

An invention that is merely another way of accomplishing a result already attained, has no value, except for purposes of protecting the field. If some prior patent claim should cover the principle and device in broad terms, its value is purely nominal.

An invention that will lower the cost of making a machine is valuable, also one that will enable it to be run with less skill; but the most valuable is that which enables a larger production, keeping the quality the same or better, and not proportionately increasing either the first cost or cost of running.

With a simple invention, always test it before trying to interest others in it.

If it is the intention to sell the invention to some firm, do not make the mistake of getting a patent before showing the idea. Too many inventions are made absolutely worthless by bad patents. There is as much chance for skill in properly preparing patent papers, as in making the invention. If a firm cares for an invention, they will prefer to have the patent papers drawn with their supervision.

An invention cannot be patented that has been in public use two years before the application.

If you think you have an idea that is valuable, it is always well to make dated drawings, and have them witnessed. If there is any litigation afterwards, dates are of prime importance.

Do not make the mistake of supposing that, having made an invention, you are entitled to all the value that is derived from it. Any bright man, by studying a process, can invent another way of accomplishing the same object. Inventors are not rare. We have men employed on salary able to invent in any direction found necessary. It requires great foresight to know what is necessary to be invented. It is proverbial that inventors do not always thrive. The trouble is that there are few capable of properly introducing an invention. The experimenting, expense, and competition entailed, make it out of the question for the ordinary inventor to personally attempt it. The proper way, therefore, is to interest some concern with you that is willing to do all the work and run all the risk for a share of the profits.

In our own experience, we buy or experiment with five to ten inventions to every one that we introduce. Of course we do not intend to waste time on useless ideas, but there are many which are so attractive in theory, their faults can only be determined by experiment.

In order to do business, we have to make the gain from the successful inventions overbalance the loss from the others.

There is an erroneous impression current to the effect that inventors are cheated out of their rights, and never get their fair share of the profits. The public at large, however, never understand how much expense, time and skill is necessary to develop a crude idea and sell it at a profit. Certain manufacturing details of a new mechanism may require months to master, yet the finished product shows no record of the struggle.

In inventing, be careful not to let such a pastime interfere with your ordinary labors. Very few can afford to make invention their sole occupation.

HOPEDALE INVENTORS.

Our firm is descended from a naturally inventive family. They have individually taken out patents in number as follows up to 1896.

The late Geo. Draper patented 38 inventions in his own name, and 4 with other joint inventors, making 42

Wm. F. Draper,	45	singly,	5	jointly,	50
Geo. A. Draper,	3	“	5	“	8
Eben S. Draper,	2	“			2
Geo. Otis Draper,	26	“	2	“	28
					130

Other inventors at present in our employ or connected with Hopedale corporations have records as follows of patents turned over to Hopedale concerns.

J. B. Bancroft,	11	singly,	3	jointly,	14
W. T. Carroll,	33	“	2	“	35
F. J. Dutcher,	3	“	4	“	7
A. B. Edmands,	7	“			7
J. W. Keeley,	1	“			1
G. W. Knight,	3	“	2	“	5
J. H. Northrop,	29	“	2	“	31
A. E. Rhoades,	15	“	2	“	17
C. F. Roper.	17	“	2	“	19
W. H. Sadler,	1	“			1
E. S. Stimpson,	17	“	3	“	20
W. I. Stimpson,	3	“	1	“	4
W. Welch,	2	“			2

Quantity is no test of quality. A large number of patents, however, even if for minor ideas, shows active creative power, and also shows that the ideas were thought of sufficient value to risk the expense of patent fees.

SPINDLES IN THE WORLD.

Taking for a unit a spindle of the highest modern efficiency, the following table shows the distribution in 1895. Statistics of the simple number of spindles are very misleading, as there is no division between Mule and Frame, and between high and low speed. We have tried to take these differences into account:

Great Britain,	42	per cent.
United States,	21	"
Germany,	7	"
Russia,	7	"
France,	6	"
India,	4.5	"
Austria,	3	"
Spain,	2	"
Switzerland,	2	"
Italy,	2	"
Belgium,	1.5	"
Japan,	1.5	"
Holland,	.3	"
China,	.2	"

Japan is gaining at the highest relative speed, and the United States is gaining at the greatest yearly increase. In Great Britain there is a stagnation, owing to loss of former markets and difficulty with labor.

The above statistics do not pretend to be accurate, but are only as relatively correct as is possible from attainable information.

SOUTHEASTERN MASSACHUSETTS UNIVERSITY
3 2922 00321 418 3

Date Due
~~Date Loaned~~

SPEC.COLL TS 1581 .D76 18
Draper, George Otis, 1867-
1923.
Facts and figures for
textile manufacturers